SCIENCE

FRIDAY, DECEMBER 18, 1914

CONTENTS

The Value of Research to Industry: DR. RAYMOND F. BACON 871

Oceanographic Cruise of the Schooner "Grampus": DR. HENRY B. BIGELOW 881

A Fossil Botanical Garden: DR. JOHN M. CLARKE 884

Recent Changes in the Boston Museum of Natural History 884

The Proposed Toronto Meeting of the American Association 885

Scientific Notes and News 886

University and Educational News 890

Discussion and Correspondence:—

Teaching and Research: PROFESSOR T. D. A. COCKERELL. *A Note on Apparatus Repair:* G. B. O. *The Tenterton Steeple and the Goodwin Sands:* MAXIMILIAN BRAAM. 891

Scientific Books:—

Roger Bacon: PROFESSOR LOUIS C. KARPINSKI. *Martin on the Birds of the Latin Poets:* HARRY C. OBERHOLSER. *Shreve on a Montane Rain Forest:* PROFESSOR DUNCAN S. JOHNSON. *Ries and Watson's Engineering Geology:* W. H. EMMONS. *Henderson's Die Umwelt des Lebens:* R. S. L. 894

The Oxidation of Nitrogen: DR. W. W. STRONG. 899

Garbage Incinerator at Barmen, Germany: JULIUS FESTNER 903

Special Articles:—

A Possible Mendelian Explanation for a Type of Inheritance Apparently non-Mendelian in Nature: DR. C. C. LITTLE. *The Structure of the Cotton Fiber:* B. S. LEVINE. 904

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE VALUE OF RESEARCH TO INDUSTRY[1]

THE large chemical industries and, in fact, all branches of chemical technology have been immensely developed during the nineteenth and twentieth centuries, and the achievements of chemistry in the arts and industries have been stupendous and varied. In particular, industrial research —definable as "the catalysis of raw materials by brains"—has been and is being increasingly fostered by chemical manufacturers, and this has led to the accruement of important novelties and improvements.

Many excellent résumés of the development of industrial chemistry during the modern chemical period have appeared in the literature. I shall only remind you that these indicate how industrial chemistry has been elevated by a continuous infusion of scientific spirit, and that manufacturing, once entirely a matter of empirical judgment and individual skill, is more and more becoming a system of scientific processes. Quantitative measurements are replacing guesswork, and thus waste is diminished and economy of production insured. In the United States, several decades ago, few industrial establishments furnished regular employment to chemists, but now American manufacturers are becoming more and more appreciative of scientific research, and the results so far obtained have resulted in far-reaching improvements. In the production of a metal from its ores, or of benzene derivatives from coal-tar, it is chemistry that points

[1] An address delivered, by invitation, at the inaugural meeting of the session of the Royal Canadian Institute, Toronto, November 7, 1914.

the way, and the more complex the problem the greater the dependence. In devising new processes and in the discovery of new and useful products, chemistry is again the pathfinder. The community is apt to overlook the extent and diversity of the services rendered by the chemist, because of the quiet and unobtrusive way in which the work is carried out.

The measure of a country's appreciation of the value of chemistry in its material development and the extent to which it utilizes this science in its industries, generally measure quite accurately the industrial progress and prosperity of that country. In no other country in the world has the value of chemistry to industry been so thoroughly understood and appreciated as in Germany, and in no other country of similar size and natural endowment have such remarkable advances in industrial development been recorded, and this, too, with steadily increasing economy in the utilization of the natural resources.

THE CHEMICAL INDUSTRIES OF GERMANY

The history of the great firm of Farbwerke vorm. Meister Lucius und Brüning at Höchst a/M., Germany, serves as an admirably typical record of the development of German chemical industry.

In 1862, two chemists and two merchants organized a firm for the manufacture of tar colors, and the plant was started the following year with five workmen, one clerk, and one chemist. One boiler of 3-horse-power supplied the power. Fuchsin, anilin blue, alkali blue, aldehyde green, methyl violet, methyl green and malachite green were the first products. In 1869, the manufacture of alizarine was taken up. In 1878, new buildings were erected for the manufacture of azo-dyes, and two years later the firm was formed into an Actien-Gesellschaft. In 1883, the manufacture of pharmaceutical preparations were started with antipyrine; in 1892, Koch's tuberculin and Behring's diphtheria serum were prepared and marketed; and in 1898 the manufacture of synthetic indigo was begun. The number of types and colors manufactured twenty-five years ago amounted to 1,750; in 1913, about 11,000 were manufactured. In 1888, the steam engines had a total horse-power of 1840; in 1913, 30,000 horse-power were required. In 1888, 1,860 workmen and 57 *chemists* were employed; in 1912, 7,680 workmen, 374 foremen, *307 chemists* and 74 other technical men were on the payroll. In 1912, 8.6 million marks were paid in wages and 5.2 million marks in salaries and bonuses.

Since Wallach began his investigation of essential oils and terpenes in 1884, the manufacture of perfumes in Germany has grown continuously. In 1895, synthetic neroli oil was prepared; in 1896, oils of jasmine and hyacinth blossoms, and, in 1908, the essential oils of lily of the valley, were synthesized. In the explosives industry the chief efforts have been directed to the manufacture of safe products. While in 1890, 4,938 tons of dynamite were produced and only an insignificant quantity of safety explosives, in 1909 the production of safety explosives amounted to 10,000 tons as compared with 8,000 tons of dynamite. The great development of the German dyestuffs industry led to developments in many other branches, especially in the sulphuric acid, chlorine, tar-oils and nitric-acid industries. The development of the cyanide process for the extraction of gold also led to the introduction of a new technical process of manufacturing synthetic indigo, based on the use of sodium amide in the alkali fusion of phenylglycin. In 1913, the selling value of the synthetic indigo on the world market amounted to

nearly $2,500,000. The demand of the dyestuffs works for coal-tar products also led to the great development in the recovery of by-products in coke manufacture. The recovery of ammonia as ammonium sulphate, a valuable fertilizing material, has grown rapidly in Germany.

The purely inorganic chemical works in Germany have been in a different position as compared with the large color works, which, with their large and excellent scientific and commercial organization, as well as their splendid financial position, represent enormous powers. The German color works long ago ceased to purchase the inorganic products they required. In 1913, they worked their own mines, made all inorganic and intermediate products themselves, not only for their own requirements, but also for sale, and controlled every branch of chemical industry. The great advance of these large concerns made it very difficult for the inorganic works to take up new manufactures to compensate for the continued falling-off in the profits on heavy chemicals.

Much is to be learned from a study of the history of German technology. We find, for instance, that the progress of industrial chemistry, especially in its synthetic branches, has lagged in the United States because the United States corporation and patent laws are unfavorable (in Germany a patent must be worked or forfeited) and because there is no large supply of cheap researchers. German conditions in these respects have been the direct causes for the German development. However, with proper legislation, the chemical industry will develop in the United States, at least to the same extent as in Germany, for American engineering ingenuity will serve to counterbalance the advantage of cheap labor; and the same applies to Canada, whose engineers have demonstrated skill and resource in many developments of importance to the Dominion.

Like Canada, the United States has unnecessarily imported too much. Given proper conditions, American industrialists can take care of a large amount of goods now being imported, and in some cases produce them here. In other cases, they could even become exporters of commodities now imported. To accomplish this, however, a large amount of research will be necessary, and, in general, considerable investments will have to be made.

THE CHEMICAL INDUSTRIES OF SWEDEN

Since most of the rivers of Canada possess waterfalls on their course, they must become increasingly important as sources of power, the basis of industry. Your swift-flowing streams, capable of supplying almost unlimited power, remind one of those which are the boast of Sweden and Norway; and like these countries, Canada has not only waterfalls, but she has many lakes, which will serve some day as large natural reservoirs for conducting the water to the power stations. It is appropriate, therefore, that brief reference be made to the chemical industries of Scandinavia.

Sweden is a land in which chemistry has played an important rôle from an early date. No less than twenty of the known chemical elements have been discovered by Swedes, and we are all familiar with the pioneer work of Scheele and Berzelius during the constructive period of chemistry.

Sweden owes to three factors its past and present position in industrial chemistry: an abundantly diversified mineral wealth; forests of enormous extent; and abundant water power. Its metal products are of notably high quality; the manufacture of cellulose in its varied forms constitutes an enormous industry; and the electrochemical industries have availed themselves of

the vast water power. Research is constantly in progress, and the results of the Swedish investigations in the electric smelting of iron ores have indicated much for a better utilization of the iron deposits in certain parts of the United States where conditions are not unlike those existing in Sweden.

THE CHEMICAL INDUSTRIES OF NORWAY

There are several features worthy of careful study in connection with the chemical industries of Norway. First is the very systematic and exhaustive manner in which the abundant water power of the country has been regulated, stored up, and pressed into the service of the constantly growing group of electrochemical industries. The highest engineering and chemical talent of Norway is patriotically enlisted in this cause, and already the road is constructed for little Norway to assume an industrial position commensurate with its geographical size and maritime facilities.

In the field of industrial organic chemistry, Norway has also shown her ability to develop an industry—the manufacture of oxalic acid. This is a branch of manufacture which has never been developed in North America, and, as there is only one plant producing oxalic acid in the United States, comparatively enormous amounts of money have normally been expended annually in the purchase of this commodity in Norway and Germany.

While the climate is severe, coal is lacking, the mineral deposits are not easily accessible, and the conditions of life are comparatively hard, the Norwegians have brought certain chemical industries to the fore. In the development of these, chemical research has had a prominent part.

THE CHEMICAL INDUSTRIES OF HOLLAND

The Netherlands offers a most interesting example of what can be accomplished in building up diversified branches of the chemical industries when there is an almost complete dependence upon foreign fuel and raw material. The evolution of the manufacture of starch, of mineral pigments, of matches, and fertilizers, as well as the industries connected with the oils and fats, are most instructive in this connection.

Providing the people of Holland remain free from military burdens, it may be predicted that the exceptionally high degree of thrift, intelligence and enterprise characterizing the Dutch will enable them to accomplish the enlargement of the field of chemical industry and to free the country from dependence upon foreign sources of supply of finished products.

THE CHEMICAL INDUSTRIES OF BELGIUM

Prior to the present war, Belgium was regarded from the standpoint of the technologist as offering a most instructive example of what can be done in a small country in the healthy development of a large group of closely allied industries. All the chemical branches dependent to a greater or less extent upon the natural products of the land had been brought to a high state of perfection. In addition, numerous chemical industries utilizing raw materials of foreign origin had been called into existence. Then, too, the ability to capture, in various directions, foreign markets for different chemical products had been revealed to an astonishing degree.

The Belgian chemists of the next decade will once more be obliged to concentrate their endeavors in building up the industries for which the little kingdom was so worthily famous—the production of staple articles of value. In this line they will, no doubt, show that high degree of inventive skill, capacity for organization and commercial acuteness which has always characterized the Belgian technologist.

THE INDUSTRIAL CHEMISTRY OF TO-DAY

The picture that technical chemistry presents to-day is quite different from that of thirty years ago. There is more brilliancy around the accomplishment of the organic than of the inorganic industries. The replacement of natural dyes by the products of coal tar, the extension of our medical resources by the manufacture of synthetic medicines, has gone far to extend the appreciation of chemical work and to produce the general conviction that chemistry is an inexhaustible field of economic possibilities. Indeed, one natural product after another falls into the domain of chemical synthesis, and chemistry is becoming the important factor in the economy of the tropical products which are used for industrial purposes. As soon as the price of such a product exceeds a certain limit, organic chemistry enters the field and synthesizes it. Tanning materials are in a struggle with the condensation products of formaldehyde and phenolsulfonic acids. Camphor could maintain its position only by large price reduction, and the prospect of synthetic rubber has held down the would-be inflated prices of the natural product. The basis of this marked development in organic chemical industries is the combined working of science and technology. The success of this intermingling is so obvious that I need not dwell on the point.

In the domain of inorganic technical chemistry things are somewhat different. Here, too, a great change has taken place. The historical sulphuric acid and soda processes have lost much ground to the ammonia-soda and electrolytic processes, and to the contact process. New branches of industries have taken root and grown up. In this field, however, the connection between scientific and technical progress is neither so obvious nor so well recognized as in the realm of industrial organic chemistry. The reason is that the advance in inorganic science, during the last decade or two, has resulted less in the discovery of new facts which had direct technical applications, than in the elucidation and working out of new theoretical views. In fact, the introduction of physical laws and physical methods into the working sphere of inorganic chemistry has led to the greatest scientific progress. The invasion of physics into chemistry has produced the splendid development of physical chemistry, the basis of which is the second law of thermodynamics, the phase rule, and the theory of electrolytic dissociation. The introduction of the electroscope into chemical analysis has opened up the new chemical world of radioactivity. Now inorganic chemical industries can gain almost as much by regarding their problems from a physical point of view as organic industries do by the application of structural considerations.

THE VALUE OF PHYSICO-CHEMICAL RESEARCH

Owing to the progress of physical chemistry, based largely upon thermodynamics and including the accurate quantitative study of the conditions determining the reactivity of substances and the velocity of chemical change, chemistry has, indeed, undergone revolutionizing changes during the past twenty-five years. The study of the behavior of catalysis comes well within the province of physical chemistry. As examples of industrial processes based upon catalytic action, I shall mention in passing the Deacon chlorine process, the contact sulphuric process, the hydrogenation of unsaturated fatty acids and their esters, the synthesis of ammonia from its elements, the oxidation of naphthalene in the production of synthetic indigo, and certain methods of surface combustion.

Fermentation industries and the whole field of agriculture depend upon physical chemistry for their further progress and development; for enzymes are essentially

catalysts and the stimulating action of small quantities of inorganic compounds on the growth of plants has been demonstrated. For instance, very small additions of manganese or zinc, or mixtures thereof, increase the yield of plant culture.

In this connection I may refer to the application of the phase rule by van't Hoff to the better utilization of the Strassfurt salt deposits, and to electrochemistry, photochemistry, and to the chemistry of colloids.

The successful solution of the problem of the oxidation of atmospheric nitrogen, the production of ammonia from its elements, and the manufacture of sulphuric acid by the contact process, were only made possible by the knowledge of the principles and methods of chemical dynamics and thermodynamics.

Further, the teachings of physical chemistry have led to the study of the conditions of absorption of drugs by the various cells and tissue juices of the body, of the part played therein by osmosis, by electrolytic dissociation, by mass, and especially by the colloidal character of the substances concerned in metabolism. Such study associated with biological chemistry has pointed the way to new methods of research which promise well for a fuller understanding of the complexities of the processes that are comprised in the physiological action for drugs.

Despite the mass of material that has thus been accumulated, a scientific basis for the preparation of physiologically active compounds is but in its infancy. The possibility of precalculating the action of a drug from its chemical structure is as yet developed to but a limited extent, as has been repeatedly brought home during recent years by the discovery of new groups of compounds possessing valuable therapeutic properties, the physiological action of which was in no way anticipated. Indeed, the recognition of the therapeutic value of some of the earlier synthetic drugs was effected, as Keane has indicated, rather in accord with Priestley's belief that all discoveries are made by chance, and has been extended with some reminiscence of his view that scientific investigation was to be "compared to a hound, wildly running after and here and there chancing on game." The hypnotic property of sulphonal was a chance discovery; the physiological action of antipyrine was initially examined on account of its supposed relation in chemical structure to kairine and allied febrifuges, which was subsequently proved to be incorrect; and the purgative properties of phenolphthalein became known from the results that followed its use to earmark, for administrative purposes, a certain kind of wine in Austria-Hungary. The commercial success of antipyrine—the profits in one year from its manufacture before the expiration of the patent are said to have reached $300,000—was followed by a hunt for further "game" and many a compound, such as acetanilide, has been called from the seclusion of chemical museums for the examination of its physiological properties.

The recognition of the therapeutic value of such substances has been followed by inquiry into the relation of their chemical structure and physiological action, with the result that the study of this relation has since become more ordered and systematic.

GEOCHEMICAL RESEARCH

A study of the manner in which certain minerals are usually found associated together in nature, commonly those which are isomorphous or which contain the same group of elements, but very often of entirely different mineralized and chemical character, is of particular importance to the commercial man, and should be of great

assistance to those chemists and physicists who study the genesis of minerals and "elements" and the so-called degradation of the latter. Just as the periodic law of Newlands and Mendeléeff was evolved from the tabular collating of chemical and physical data, and was found capable of prophetic use, so one may learn and predict much from a study of the known associations of minerals, and particularly those of the rare metals. One has the advantage of knowing that minerals have been produced under natural conditions where no mistakes or errors of manipulation can have occurred and where no difficulties due to want of time, material, or facilities for experimenting existed; in other words, where the personal factor was absolutely non-existent.

Probably the most promising field for research exists in the oldest plutonic rocks, and particularly in such pegmatites and other extremely old granitic and other rocks as have been subjugated, at great depth and pressure and at high temperatures, to the action of intruded flows of fused mineral matter from still deeper-seated sources, or of vaporized mineral matter of similar origin. Such rocks exist in many parts of the world, but the pegmatites of Norway, the old granites of Greenland, and many of the old but less highly crystalline tin-bearing deposits of Cornwall, may be instanced as likely to throw light on the origin of certain metals, and especially of those at the "heavy" and "light" ends of the periodic table. Perhaps

> There is in this business more than nature
> Was ever conduct of.

It is probable that some of the missing heavy elements near the uranium end of the table may be found in such rocks, and that certain light elements, for which room may have to be made in the table, may also be discovered.

The comprehensive investigations in progress at the geophysical laboratory of the Carnegie Institution illustrate the change now occurring in geochemical research.

THE VALUE OF RESEARCH IN METALLURGY

To the valuable properties of the many alloys of iron now manufactured, from carbon steel to the complex alloy known as high-speed tool steel, which contains no less than five different elements apart from the iron itself, is to be attributed the great progress which has been made, whether in the arts of peace or in war. There is one simple concrete instance—the modern automobile. Eliminate the alloy steels used in its construction, and it could no longer be produced. The combination of lightness and strength necessary in such modern products is only made possible by the use of special alloy steels.

While the progress made in alloy steels since Hadfield's first researches in 1882 and onwards has been wonderful, indeed, the field for research is still an immense one, full of difficulties, disputed points, and important problems. It is true that there may not be at the present time room for such abnormal discoveries in ferrous metallurgy as in the past, but investigators are quietly and steadily augmenting our knowledge of iron and its alloys, and the value of such research work is generally recognized.

It remains to mention in this connection that the science of metallography, which has so materially aided the progress of metallurgy, has been developed by the assistance of the phase rule.

Research work of an elaborate nature is constantly being conducted by several manufacturers, especially at Homestead, Pa., by the United States Steel Corporation, which has to date expended over $800,000 in investigations on the electro-

thermic production of steel alone. However, metallurgical research laboratories are still comparatively uncommon. Very few iron furnaces or smelting plants are without a control laboratory, which has come about notwithstanding the opposition of "practical men," and the research laboratory will eventually win a similar victory.

The great problems at present in the metallurgy of zinc are in the concentration of the ore and in the treatment of flotation concentrate. The latter produces the troubles that fine ore always does; it is difficult to roast, and the distillation of it is attended with troubles.

Viewing the present status of the practise in zinc smelting, one is impressed by the high extraction results, the low fuel consumption made possible by regenerative gas-firing, and the reduction of labor involved in the art.

In copper metallurgy, the leaching of copper ores and electrolytic deposition for precipitating are receiving increased attention. In electrolytic copper refining, promising progress has been made in the treatment of anode slimes; and more attention is being paid to the recovery of by-products, new uses for two of which, selenium and tellurium, are required.

COOPERATION BETWEEN SCIENCE AND INDUSTRY

While those engaged in a profession which has so many ramifications as has chemistry in its numerously various applications to all modern activities, must cooperate to effect advancement, before such cooperation can be effective, there must be a mutual understanding between chemists as a profession and industrialists. Many American chemical manufacturers still follow rule-of-thumb methods without having any idea of the underlying principles which are immutable. These manufacturers must be induced to recognize the actuality of such principles and to realize fully that an actual comprehension thereof is necessary for the attainment of that measure of success necessary to maintain uniform quality and maximum output of product.

In this connection, I may say that the system of practical cooperation between industry and learning, founded by the late Dr. Robert Kennedy Duncan, has had eight years of trial. The outcome of my eminent predecessor's labors, The Mellon Institute, through its industrial fellowship system, represents a happy and successful alliance between science and industry, for a valuable and permanent relation has been established by the solution, at the institute, of many important manufacturing problems.

THE METHODS OF ATTACKING INDUSTRIAL PROBLEMS

When a chemical industry has problems requiring solution, these problems can be attacked either inside or outside of the plant. If the policy of the management is that all chemical problems are to be investigated only within the establishment, a research laboratory or at least a research chemist must be provided for the plant or for the company. At present, in the United States, probably not more than 100 manufacturing establishments have research laboratories or employ research chemists, although at least five companies are spending over $100,000 per year in research. In Germany, and perhaps also in England, such research laboratories in connection with chemical industries have been much more common. The great laboratories of the Badische Anilin und Soda Fabrik and of the Elberfeld Company are striking examples of the importance attached to such research work in Germany, and it would

be difficult to adduce any stronger argument in support of its value than the marvelous achievements of these great firms.

An unfortunately frequent difficulty encountered in the employment of research chemists, or in the establishment of a research laboratory, is that many manufacturers do not appear to grasp the need or importance of such work, or know how to treat the men in charge so as to secure the best results. The industrialist may not even fully understand just what is the cause of his manufacturing losses or to whom to turn for aid. If he eventually engages a chemist, he is sometimes likely to regard him as a sort of master of mysteries who should be able to accomplish wonders, and, if he can not see definite results in the course of a few months, is occasionally apt to consider the investment a bad one and to regard chemists, as a class, as a useless lot. It has not been unusual for the chemist to be told to remain in his laboratory, and not to go in or about the works, and he must also face the natural opposition of workmen to any innovations, and reckon with the jealousies of foremen and of various officials.

From the standpoint of the manufacturer, one decided advantage of the policy of having all problems worked out within the plant is that the results secured are not divulged, but are stored away in the laboratory archives and become part of the assets and working capital of the corporation which has paid for them; and it is usually not until patent applications are filed that this knowledge, generally only partially and imperfectly, becomes publicly known. When it is not deemed necessary to take out patents, such knowledge is often permanently buried.

In this matter of the dissemination of knowledge concerning chemical practise, it must be evident to all that there is but little cooperation between the manufacturers and the universities. Chemical manufacturers have been quite naturally opposed to publishing any discoveries made in their plants, since "knowledge is power" in manufacturing as elsewhere, and new knowledge gained in the laboratories of the company may often very properly be regarded as among the most valuable assets of the concern. The universities and the scientific societies, on the other hand, exist for the diffusion of knowledge, and from their standpoint the great disadvantage of the above policy is this concealment of knowledge, for it results in a serious retardation of the general growth and development of the science in its broader aspects, and renders it much more difficult for the universities to train men properly for such industries, since all text-books and general knowledge available would in all probability be far behind the actual manufacturing practise. Fortunately, the policy of industrial secrecy is becoming more generally regarded in the light of reason, and there is a growing inclination among manufacturers to disclose the details of investigations, which, according to tradition, would be carefully guarded. These manufacturers appreciate the facts that public interest in chemical achievements is stimulating to further fruitful research, that helpful suggestions and information may come from other investigators upon the publication of any results, and that the exchange of knowledge prevents many costly repetitions.

INDUSTRIAL FELLOWSHIPS

If the manufacturer elects to refer his problem to the university or technical school, such reference may take the form of an industrial fellowship and much has been and may be said in favor of these fellowships. They allow the donor to keep secret for three years the results secured, after

which they may be published. They also secure to him patent rights. They give highly specialized training to properly qualified men, and often secure for them permanent positions and shares in the profits of their discoveries. It should be obvious at the outset that a fellowship of this character can be successful only when there are close confidential relations obtaining between the manufacturer and the officer in charge of the research; for no such cooperation can be really effective unless based upon a thorough mutual familiarity with the conditions and an abiding faith in the integrity and sincerity of purpose of each other. It is likely to prove a poor investment for a manufacturer to seek the aid of an investigator if he is unwilling to take such expert into his confidence and to familiarize him with all the local and other factors which enter into the problem from a manufacturing standpoint.

According to the system of industrial research in operation at The Mellon Institute of Industrial Research of the University of Pittsburgh,[2] a manufacturer having a problem requiring solution may become the donor of a fellowship: said manufacturer provides the salary of the fellow selected to conduct the investigation desired, the institute furnishing such facilities as are necessary for the conduct of the work.

The money paid in to found a fellowship is paid over by the institute in salary to the investigator doing the work. In every case, this researcher is most carefully selected for the problem in hand. The institute supplies free laboratory space and the use of all ordinary chemicals and equipment. The fellow who is studying the problem works under the immediate supervision of men who are thoroughly trained and experienced in conducting industrial research.

At the present time, The Mellon Institute, which, while an integral part of the University of Pittsburgh, has its own endowment, is expending over $150,000 annually for salaries and maintenance. A manufacturer secures for a small expenditure—just sufficient to pay the salary of the chemist engaged on the investigation—all the benefits of an organization of this size, and many have availed themselves of the advantages.

Each fellow has the benefit of the institute's very excellent apparatus, chemical and library equipment—facilities which are so essential in modern research; and because of these opportunities and that of being able to pursue post-graduate work for a higher degree, it has been demonstrated that a higher type of research chemist can be obtained by the institute for a certain remuneration than can be generally secured by manufacturers.

There is a scarcity of men gifted with the genius for research, and it requires much experience in selecting suitable men and in training them to the desirable degree of efficiency, after having determined the special qualities required. Important qualifications in industrial researches are keenness, inspiration and confidence; these are often unconsidered by manufacturers, who, in endeavoring to select a research chemist, are likely to regard every chemist as a qualified scientific scout.

All researches conducted at The Mellon Institute are surrounded with the necessary secrecy, and any and all discoveries made by the fellow during the term of his fellowship become the property of the donor.

It is well said in the *Reports* of the Twelfth Census of the United States that

[2] On the progress which has been made in industrial fellowships, see R. F. Bacon, *J. Frankl. Inst.*, November, 1914, 623.

probably no science has done so much as chemistry in revealing the hidden possibilities of the wastes and by-products in manufactures.

This science has been the most fruitful agent in the conversion of the refuse of manufacturing operations into products of industrial value. . . . Chemistry is the intelligence department of industry.

Yet we are often uninformed concerning the character and amount of the by-products going to waste in our immediate neighborhoods, a careful study of which might lead not only to financial reward for the manufacturer as well as for ourselves, but might also prevent much of the present pollution of our streams and of the air we breathe.

It is not only very desirable, but will soon become really necessary for manufacturers to avail themselves more freely of the assistance of the experts in universities, technical schools and scientific institutes.

THE FUTURE OF RESEARCH IN CANADA

With a strong and prosperous nation to the south, expert in manufacturing operations and constantly endeavoring seriously to gain markets for its surplus production, Canada has developed less rapidly from an industrial viewpoint than if she occupied a more isolated position geographically. European and American products have long been familiar to the Canadian people, and the manufacturers of the Dominion have had an arduous struggle in establishing their wares. But this time is past. Since 1910, all over Canada, new factories have been erected, new products are being manufactured, and new plans for the future are being considered.

With her diversified and abundant mineral resources, her extensive forests and her great power sources, Canada has indeed wonderful industrial prospects. Noteworthily helpful work in the opening-up of various fields has been done by your Department of Mines, whose distinguished division Directors, Dr. Eugene Haanel, of the Mines Branch, and Dr. R. W. Brock, of the Geological Survey, have been pioneers in your industrial development; but as your mineral, wood and water-power wealth become more and more apparent, just so much more will the need for and value of industrial research become apparent to your manufacturers. As in other countries, chemistry will be the pathfinder.

Canada is but at the adolescent period in her industrial life. Your patriotism need not therefore be shocked by apparently

Nourishing a youth sublime
With the fairy tales of science.

Many of the natural secrets of your vast country have been gained, laboriously wrought for, but rich rewards await your coming generations who inherit the knowledge gained by an awakened conscience of research.

RAYMOND F. BACON
UNIVERSITY OF PITTSBURGH

OCEANOGRAPHIC CRUISE OF THE U. S. BUREAU OF FISHERIES SCHOONER "GRAMPUS," JULY AND AUGUST, 1914

DURING the past summer the fisheries schooner *Grampus* has continued the oceanographic work of 1912 and 1913,[1] in my charge, with Mr. W. W. Welsh as assistant. The general problem laid out for the *Grampus* cruises of the past three years has been the study of currents, salinities, temperatures and plankton of the coastal waters off our eastern seaboard. In 1912 the work was confined to the Gulf of Maine; in 1913 it extended over the whole

[1] H. B. Bigelow, "Oceanographic Cruises of the U. S. Fisheries Schooner *Grampus*, 1912–13," SCIENCE, N. S., Vol. 38, No. 982, pp. 599–601, October 24, 1913; "Explorations in the Gulf of Maine, July and August, 1912, by the U. S. Fisheries Schooner *Grampus*. Oceanography and Notes on the Plankton," *Bull. M. C. Z.*, Vol. 58, pp. 31–147, 9 pls., 1914.

breadth of the continental shelf between Cape Cod and Chesapeake Bay, with a repetition of the Gulf of Maine stations; and for 1914 we planned to continue our survey eastward from Cape Cod, as far as Cape Breton and Cabot Straits, to connect with the observations taken by the U. S. revenue cutter *Seneca* during the preceding spring. Special attention was to be devoted to George's Bank, important oceanographically because of its position as a rim between the cold water of the Gulf of Maine and the Gulf Stream; to the effect of St. Lawrence water on the physical characters of the coast water in general, and on the Gulf Stream; and to the possible influence of the Labrador Current on our coasts. Experience has shown that the coastal water, bounded as it is by the coast on one hand and the Gulf Stream on the other, is best studied by successive sections normal to the coast; and our stations were located with this end in view. We were able to carry out this program as far as Halifax. But the European war forced us to relinquish the stations further east; and the time thus released was devoted to repeating our Gulf of Maine stations, and to running a section from Marthas Vineyard to the Gulf Stream for comparison with the preceding year.

The general program of work for each station consisted of serial temperatures and water samples, at sufficiently small vertical intervals to afford satisfactory salinity and temperature sections (3 to 7 according to the depth); a vertical haul with the Hensen quantitative net, especially instructive for copepods, less so for larger and more active organisms; surface hauls with the fine (No. 20) and coarse (No. 5) silk nets; and hauls at intermediate depths with one or more of the large nets, according to depth. When two were used they were attached simultaneously to the wire rope, the Helgoland net usually at the lower, the "Michael Sars" net at the higher level. In addition, the surface temperature was taken hourly throughout the cruise; and the color of the sea frequently recorded by the Forel scale. Current measurements occupy so much time that we obtained only one complete record of an entire tide from the ship at anchor.

Since 1912 considerable additions have been made to the outfit of the ship; and this year we were provided with six stopcock water-bottles, an Ekman reversing water-bottle, three Ekman current-meters, a Lucas sounding-machine, and twelve reversing deep-sea thermometers of the latest type, especially valuable because by their use the probable error of the temperature readings was reduced from .15° to .03° F. Another refinement of apparatus was the attachment of the thermometer frames to the stopcock water-bottles, allowing the two sets of instruments to be used simultaneously in series, thus shortening the time for each set. We also carried a very complete set of horizontal and quantitative plankton nets, besides the usual trawls, fishing gear and harpoons; in short, we can at least congratulate ourselves on a thoroughly modern oceanographic outfit.

Our first section, across the Gulf of Maine and the western end of George's Bank, to the Continental Slope, occupied us from July 19 to July 21. Being then well within the sweep of the Gulf Stream, as shown by the temperature and plankton, we skirted the outer edge of the Bank to about longitude 66° 10′ W., whence we drew a second section across the Bank, to the deep basin of the Gulf. It would have been of interest to have extended the work to the abyssal depths further off shore; but our gear limited our observations to the upper 500 meters.

We next drew a section across the deep gully known as the "Eastern Channel," between George's and Brown's Banks, of great oceanographic interest because it is the only connection between the basin of the Gulf below the 100-fathom contour, and the deeps of the Atlantic; occupying stations successively in the gully, on Brown's Bank, in the channel north of the latter, and on the coastal bank off Cape Sable. On July 25 the *Grampus* anchored in Shelburne, Nova Scotia.

Two days later we made a current station a few miles off that port, anchoring the vessel in 30 fathoms of water, and taking measure-

ments of the surface current hourly for twelve hours (thus covering an entire tide, ebb and flood), and a few bottom current readings. The calm weather of that and the two preceding days gave an ideal opportunity for this work; hence the strong dominant set to the southwest which our instruments revealed is probably of considerable importance as an index of the long-shore flow of St. Lawrence water. From this point we ran a section across the coastal shelf, via Roseway Bank and the deep but circumscribed basin between it and La Have Bank, to the continental shelf, where we towed and took oceanographic observations to 500 meters.

Our program now called for a section crossing the shelf obliquely, to Halifax, and the first half of this line was successful. But an easterly storm drove us off our course, to shelter in La Have River, where we were held prisoners, first by northeast winds, then by fog, and finally by a violent southwest gale for four days. On reaching Halifax, August 2, we learned of the European war; and shortly received orders to return to United States waters.

On August 6 we sailed from Halifax, planning to make first a section across the Continental shelf normal to the coast as far as Emerald Bank; and then to run to the Gulf of Maine, making stations en route. The section was successful, and we were lucky enough to vary the monotony of the plankton hauls by the capture of a large swordfish, and of a sunfish (*Mola mola* Linn.). But thick fog set in on August 8 and drove us once more to Shelburne for shelter. Until the eleventh we lay at anchor, waiting for a change of weather; then lost patience and put to sea again. Our next field was the Gulf of Maine, where we located our stations at the same positions as those of 1912 and 1913, first in the northeast corner, then off Mt. Desert rock, and along shore to Gloucester, where we arrived on August 15. A week was spent in port; and on the 22d the *Grampus* sailed again, running east to the center of the gulf, and then to Cape Cod. Passing through Vineyard Sound we took our departure from No-Mans-Land on August 25 for a section across the Continental shelf, with stations at the 20-, 35- and 80-fathom contours, and one over the 1,000-fathom curve. We had supplied ourselves in Gloucester with bait and a long-trawl, and made two sets for tile fish (*Lopholotilus chamæleonticeps*) on the twenty-sixth. In 80 fathoms we caught only two; but in 105 fathoms an hour's set yielded 19, the aggregate weight being about 350 pounds. We occupied three stations during the run back to Gloucester, where we arrived August 28.

During the cruise complete oceanographic data were taken at 52 stations, ranging in depth from 15 to 250 fathoms; 126 tows were made with the horizontal nets: the quantitative net was used at 26 stations. The distance sailed was about 2,000 miles.

Statements as to the scientific results must await the completion of titrations of the water samples and the general examination of the plankton samples: the general report on the cruise, like that on the cruises of 1912[2] and of 1913 will be prepared in the Museum of Comparative Zoology.

Henry B. Bigelow

INTERNATIONAL OCEANOGRAPHIC EXPEDITION

At the present time arrangements are being completed to despatch the International Oceanographic Expedition under the command of J. Foster Stackhouse, F.R.G.S., for a seven years' voyage to chart the seas, and to determine as far as possible the exact position of the large number of rocks and reefs which have been reported during the last century.

Not since the days of the *Challenger* has so great an enterprise been undertaken, and it is highly desirable that no time be lost in making the fullest inquiries into these hidden dangers to navigation.

Over 3,500 dangers have been reported in the Pacific Ocean alone, and some of these no doubt account for the fact that during the last

[2] *Loc. cit.*

three years, the great insurance corporation of Lloyds has reported that over 134,000 tons of shipping in which they were interested, had mysteriously disappeared, involving a loss of over $13,000,000.

Whilst the first duty of the expedition will be to accurately chart the seas, the vessel will carry a staff of twelve scientific men, who will make a thorough investigation of all places visited, and in little known regions, parties will be left for short periods to carry on work in many branches of science. The expedition has been fortunate in enlisting the practical support of many governments, and after consultation with hydrographers in many parts of the world, the following itinerary has been agreed upon.

Leaving London in June, surveying work will be carried on in the North Atlantic, particularly in the vicinity of the sinking of the *Titanic*—where on three occasions a rock has been reported—thence down the Atlantic, after calling at several ports in this country, to the Panama Canal.

For the next four years investigations will be made in the Pacific Ocean, calling at most of the little known islands, and extending in its operations from the Sea of Ohkotsk to King Edward VII. Land.

On leaving the Pacific, the expedition will continue its work amongst the islands of the East Indies thence to Zanzibar by way of Columbo, Seychelles and Mombasa. Later considerable time will be spent in the unknown waters south of Madagascar. After calling at Natal, the vessel will once more sail for Antarctic waters, and endeavor to find the coast line between Queen Mary Land and the Weddell Sea. On leaving these latitudes a thorough investigation will be made of the Sandwich Islands, which are at present unsurveyed. Continuing westward oceanographic work will be carried on around South Georgia and the Falkland Islands. From Port Stanley a line of soundings will be made to Montevideo, examining several shallow patches in the South Atlantic, and thence by way of Trinidad, Martin Vaz and Cape Verde Islands to London.

A FOSSIL BOTANICAL GARDEN

THE New York State Museum has received from Willard Lester, Esq., a deed of gift of about three acres of land in the town of Greenfield, two miles west of Saratoga Springs, which include the widely known "Cryptozoon Ledge," and this little property is set apart as a public geological park to be preserved and protected by the state because of its scientific interest.

The acquisition of this natural monument by free gift from a distinguished citizen of the state is not only the expression of a fine sentiment, but it brings under authoritative care a noteworthy natural phenomenon. The Cryptozoon is a marine calcareous alga which grew in great spherical bodies and in the Cambrian seas which deposited the limestones of this park, they were so abundant as to form extensive reefs. The Hoyt (Cambrian) limestone here forms a ledge which has been planed off by the ice sheet so that the Cryptozoa are smoothed down to a level surface and their interior structure beautifully displayed over an area of about a half acre. The gift, however, includes the extension of this ledge into other natural rock faces and abandoned workings of the old Hoyt quarry from which the geological formation takes its name.

The little property which is to be known as the "Lester Park" is of great natural beauty, both in itself and in its approaches, but not the least interesting thing about it is the fact that it is given to the state because of its geological and educational worth.

JOHN M. CLARKE

RECENT CHANGES IN THE ACTIVITIES OF THE BOSTON NATURAL HISTORY SOCIETY

ON Wednesday evening, November 18, Professors H. L. Clark and Alexander McAdie addressed the first of the general meetings of the society which are being resumed this season. Dr. Clark spoke on New Australasian Echinoderms collected by S. S. *Endeavor* and Dr. McAdie spoke upon Exploring the Air. The interest shown by the large number of members present and the number of informal

discussions which took place afterward around the refreshment tables in the library augured well for the success of the new series of lectures.

It is the plan of the committee in charge to hold these gatherings on the first and third Wednesdays of each month until the middle of May. A large number of important communications have been promised by many officers of the various scientific establishments about Boston and Cambridge. Among these may be mentioned especially Professor M. L. Fernald who at the next meeting will speak upon the Flora of Block Island in Relation to that of Cape Cod. At the third meeting Professor Wallace W. Atwood will address the society on Mesa Verde, with remarks upon the ancient cliff dwellings in that region. Papers have also been promised by Professor W. M. Davis, on his recent researches on the Reefs of the South Pacific, by Professors J. B. Woodworth, P. E. Raymond, R. A. Daly, C. T. Brues, G. H. Parker, R. T. Jackson, H. W. Shimer, C. Palache, as well as by Dr. H. B. Bigelow and Mr. C. W. Johnson, the curator of the society's museum.

Many changes have been made in the Museum building since the lectures were discontinued five years ago. The lecture hall has been completely renovated and reequipped throughout, so that it is now an attractive and cheerful meeting place. Even greater changes may be seen in the other parts of the building. The museum has definitely decided to lay special emphasis on exhibits of New England natural history and with this end in view has entered into a scheme of cooperation with the University Museum in Cambridge. The long unused collections of foreign material are being sent there and the space devoted to exhibits of modern groups of New England mammals and birds. The other branches of New England natural history are also being appropriately displayed.

THE PROPOSED TORONTO MEETING OF THE AMERICAN ASSOCIATION

THE University of Toronto and the scientific men of the city had extended a cordial invitation to the American Association for the Advancement of Science and the Affiliated Societies to meet in Toronto a year hence. The circumstances which will make this impossible are explained in the following letters, addressed to Dr. L. O. Howard, permanent secretary of the association. Dr. Robert W. Falconer, president of the university, writes:

I have had a meeting of the committee which the university appointed to make arrangements for the reception of the American Association for the Advancement of Science, which accepted our invitation to meet here a year ago from next December. Our committee had been intending to use every effort to make the meeting a highly successful one, and we were hoping to create a widespread interest in the association. However, the outbreak of this terrible war has made an entirely new situation. At present the war hangs over us like a cloud so heavily that it would be very hard indeed for us to arouse interest in a scientific meeting. Also, the financial situation is anything but promising. We can not hazard any conjecture as to the length of the war, though we are making preparations on the assumption that it may last for another year at least. What condition we shall be in then no one can tell. Our committee thought that it was only right that I should thus place our conditions before you at this early stage on the chance that you might be able to change the place of meeting and come to us later, at a time when we shall be able to give you a welcome that we would be anxious to accord the association.

Professor J. C. Fields writes on behalf of the local committee:

At a meeting of the local executive committee we had an extended discussion on the prospects of the meeting of the American Association for the Advancement of Science to which we folks up here were all looking forward with so much interest. In view of the conditions already induced by the war and the uncertainty of the future it was the general disappointed sense of the members that we might not be in a position to arouse sufficient local interest or otherwise be able to assure such a success as we should wish for the meeting. Here everything is disorganized by the war and its issues overshadow everything else. Students and members of the faculty are drilling and many are likely to go to the front, so that we hardly know what will be the position of affairs here by this time next year. The members of the committee

thought that you might perhaps still be able to arrange for a meeting-place a year from December and that the association would do us the honor of meeting here some time later on when we have reverted to normal conditions.

SCIENTIFIC NOTES AND NEWS

At the Philadelphia meeting Section C will hold a session on the afternoon of Thursday, December 31, for the reading of papers, and a second session, jointly with Section K and the Society of American Bacteriologists, on Friday, January 1, at 10 A.M. The latter will be devoted to a symposium on "The Lower Organisms in Relation to Man's Welfare," for which the following program has been arranged:

"Theories of Fermentation," Vice-president C. L. Alsberg.

The general mechanism of the action of ferments: "Enzyme Action," C. S. Hudson.

A discussion of the chemical changes involved in the action of enzymes:

"Rôle of Microorganisms in the Intestinal Canal," A. I. Kendall.

"Use of Bacteria in the Treatment of Textile Fibers," F. P. Gorham.

"Microorganisms in their Application to Agriculture," C. E. Marshall.

Section K (Physiology and Experimental Medicine) will hold two meetings in Philadelphia during Convocation Week.

1. Thursday, December 31, 2 P.M. Laboratory of Hygiene, University of Pennsylvania.
   Vice-presidential address: Dr. Theodore Hough, "The Classification of Nervous Reactions."
   Symposium on Ventilation (jointly with the Society of American Bacteriologists):
   (a) "Air-borne Diseases," Dr. A. C. Abbott, University of Pennsylvania.
   (b) "Fundamental Physical Problems of Ventilation," Dr. E. B. Phelps, United States Hygienic Laboratory.
   (c) "Standards of Ventilation—Hygienic and Æsthetic," Dr. C.-E. A. Winslow, New York State Commission of Ventilation.
   (d) "Modern Developments in Air Conditions," Mr. D. D. Kimball, New York State Commission of Ventilation.
2. Friday, January 1, 11 A.M. Laboratory of Hygiene, University of Pennsylvania.
   Symposium on the Life of the Lower Organisms in Relation to Man's Welfare (jointly with Section C and the Society of American Bacteriologists).

The program will be announced later.

The program for Section M, Agriculture, is now complete. A single session will be held, on December 30, in the engineering building of the University of Pennsylvania, beginning at 2 P.M. The president of the association, Dr. Charles W. Eliot, will preside at the opening of the session, during the presentation of the address of the vice-president, Dr. L. H. Bailey, on "The Place of Research and of Publicity in the Forthcoming Country Life Development." A symposium will follow, on The Field of Rural Economics, participated in by the following speakers:

"Rural Economics from the Standpoint of the Farmer," Hon. Carl Vrooman, assistant secretary of agriculture.

"Credit and Agriculture," Professor G. N. Lauman, college of agriculture, Cornell University.

"Marketing and Distribution Problems," Mr. C. J. Brand, chief officer of markets, U. S. Dept. of Agriculture.

"The Distinction between Efficiency in Production and Efficiency in Bargaining," Dr. T. N. Carver, Harvard University.

A dinner was given in Boston on December 7 to celebrate the fiftieth anniversary of the connection of Professor Robert H. Richards with the Massachusetts Institute of Technology as student and teacher. The speakers were President Richard C. Maclaurin, in behalf of the institute; Mr. Eben S. Stevens of the same graduating class with Professor Richards, '68, of Quinebaug, Conn., in behalf of his fellows at the school; Professor Chas. R. Cross, '70, in behalf of the faculty and Jasper Whiting, '89, president of the Alumni Association in behalf of his association. The presentation was made to the institute of a portrait of Professor Richards by Miss Margaret F. Richardson, of Boston. It presents him, seated, considering a question which the open letter in his hand has brought to him.

At his elbow on the table are bulky volumes typifying his contributions to the literature of mining, while the upper right-hand field of the background shows a blackboard covered with figures and diagrams bearing on ore-dressing.

AT the Academy of Natural Sciences of Philadelphia on Tuesday evening, November 24, Dr. Henry Fairfield Osborn was presented with a Hayden medal. In presenting the medal Dr. Samuel G. Dixon called attention to the fact that Mrs. Emma W. Hayden, widow of the well-known scientific man, Ferdinand Venderveer Hayden, had established a deed of trust arranging for a sum of money and a bronze medal to be given annually to the author of the best publication, exploration, discovery or research in geology or paleontology, or a similar subject. Professor James Hall, of Albany, received the award in the first instance and the other nine succeeding him were Edward D. Cope, 1891; Edward Suess, 1892; Thomas H. Huxley, 1893; Gabriel August Daubree, 1894; Carl H. Von Littel, 1895; Giovanni Capellini, 1896; Alexander Petrovitz Karpinski, 1897; Otto Torell, 1898; Giles Joseph Gustav Dewalzue, 1899. In 1900 the deed of trust was modified so as to award a gold medal every three years. The first to receive the new medal was Sir Archibald Geikie; the second was Dr. Charles D. Walcott in 1908 and the third John Casper Branner in 1911.

PROFESSOR WILLIAM T. SEDGWICK, of the Massachusetts Institute of Technology, was elected president of the Massachusetts Public Health Association at its recent meeting at Jacksonville, Florida.

PROFESSOR GEORGE CHANDLER WHIPPLE, Professor W. T. Sedgwick, Dr. Milton J. Rosenau, Dr. William J. Gallivan, Dr. David L. Edsall and Dr. Joseph E. Lamoreaux, have been appointed the six members of the advisory council to Massachusetts' state commissioner of health, Dr. Allan J. McLaughlin.

DR. RICHARD P. STRONG, of the department of tropical medicine in the Harvard Medical School, has been appointed director of the laboratories of the hospitals and of research work of the United Fruit Co. The significance of the appointment is suggested in a letter from the Fruit Company to the University:

> Through a desire to cooperate with Harvard University in its investigation of tropical diseases we have properly equipped our hospitals with laboratories and have ample material constantly available in our wards, which we desire to place at your disposal for research in connection with the prescribed study of tropical diseases embodied in your tropical school.

THE Paris Academy of Medicine elected, on November 10, as national associate, Dr. Langlet, professor and director of the Ecole de médecine de Reims and mayor of that city.

THE grand cross of the Order of Alfonso XII. has been presented to the professor of pharmacy at the University of Madrid, Dr. J. R. Carracido, who is also a senator, and the Isabella cross to Dr. S. Recasens, professor of gynecology at the same institution.

A PRESS cablegram from Berne states that M. Hugo Claparède, professor of psychology in the University of Geneva, son of the Swiss minister to Berlin, has been dismissed from the university by the Swiss federal council on the ground that his expressed views concerning the violation of Belgian neutrality are inconsistent with the observance of neutrality of Switzerland. Professor Claparède had offered his resignation, following a demonstration against him by the students, but the federal council declined to accept it and instead dismissed him. The students' demonstration occurred on November 24 as Professor Claparède entered his classroom and read an address in which they asked him to resign, because "your attitude prohibits you to continue to occupy a public post remunerated by the state." Later the matter was brought up in the federal council through an interpellation by Deputy de Rabours.

MR. DAVID T. DAY has resigned from the United States Geological Survey to enter private practise. He has served the federal bureau since 1886, having been chief of the

division of mining and mineral resources until 1907.

Professor Eugen Oberhummer, of the University of Vienna, who has been appointed visiting Austrian professor to Columbia University, is expected to lecture during the second semester of the present year. Dr. Oberhummer visited the United States in 1910 and lectured in the geography departments at Harvard, Yale, Columbia, Johns Hopkins, Chicago, Wisconsin and other American universities.

Professor George R. Lyman, of the biology department, has resigned from the faculty of Dartmouth College, to accept a position as plant pathologist in the Department of Agriculture.

Mr. F. E. Watson has been appointed an assistant in the department of invertebrate zoology of the American Museum of Natural History. He will devote the greater portion of his time to Lepidoptera. Mr. Adolph Elwyn, who for the past nine years has been assistant in the department of anatomy and physiology, has resigned his position to become instructor in histology and biology at the Long Island College Hospital. Mr. Clarence R. Halter has been appointed to succeed Mr. Elwyn.

Professor William L. Bray, of Syracuse University, has been granted leave of absence for the current year and will spend the winter with his family in the Bronx, New York. During the summer and early fall, Professor Bray has been making a general survey of the vegetation of New York state with a view to the preparation of a bulletin to be published by the New York State College of Forestry. The results of the field exploration and collections will be worked up at the New York Botanical Garden during the winter.

Mr. William B. Peters, of the department of preparation of the American Museum of Natural History, and Mr. Prentice B. Hill, assistant in the department of geology, have returned from Weyer's Cave, Virginia, where they secured a quantity of material from grottoes which have lately been discovered in the cave. This is to be used, together with the collection made last year, in the reproduction of a typical grotto in the museum, work on which is progressing.

Dr. Arthur G. Webster, of Clark University, addressed the Chicago Chapter of the Sigma Xi at its regular autumn quarter meeting on December 5, upon the topic "The Rôle of Chance in Scientific Discovery."

The Mütter Lecture on Surgical Pathology for 1914 was given in the Thompson Hall of the College of Physicians of Philadelphia, on December 4, by Dr. Fred H. Albee, of New York City, on "The Fundamental Principles Involved in the Use of Bone Grafts in Surgery."

The will of the late Dr. Charles Sedgwick Minot, Stillman professor of comparative anatomy at the Harvard Medical School, contains a bequest of $1,000 for the improvement and increase of the embryological collection which he established at the Harvard Medical School, to which he left his scientific apparatus, books and pamphlets. Dr. Minot also bequeathed $2,000 to the Boston Museum of Natural History for its library.

Dr. Albert Charles Peale, geologist of the U. S. Geological Survey from 1871 to 1898, subsequently and till recently aid in the section of paleontology of the U. S. National Museum, died on December 6, aged sixty-five years.

Professor Angelo Celli, who held the chair of hygiene at the University of Rome and was at the same time chief of the National Board of Health and senator, has died at the age of fifty-seven years.

Dr. Alexander Campbell Fraser, professor emeritus of logic and metaphysics in Edinburgh University, a distinguished writer on philosophical subjects, has died at the age of ninety-five years.

Nils Christoffer Dunèr, formerly director of the observatory at Upsala, Sweden, died on November 10, in his eightieth year.

THERE have been killed in the war, Peodwaair Frick, director of the Royal School of Forestry at Münden, and Dr. Heinz Michaelson, assistant in the Institute for Oceanography in Berlin.

THE directors of the Fenger Memorial Fund announce that the sum of $600 has been set aside for medical investigation in 1915. The money will be used to pay all or part of the salary of a worker, the work to be done under direction in an established institution, which will furnish the necessary facilities and supplies free of cost. It is desirable that the work undertaken should have a direct clinical bearing. Applications giving full particulars should be sent to L. Hektoen, 629 S. Wood St., Chicago, before January 15, 1915.

IN the will of the late Miss Dessie Greer, an annual member of the American Museum of Natural History, the museum is designated as the ultimate beneficiary of a fund of $90,000.

BY the will of the late William Endicott, of Boston, a bequest of $25,000 for cancer research is made to Harvard University.

THE American Museum of Natural History has received from Messrs. M. Guggenheim and Sons the gift of a small collection of prehistoric objects found in a copper mine at Chuquicamata, Chile. The collection consists for the most part of hafted stone hammers and wooden scrapers. These were the implements used by the Indians in pre-Spanish days in collecting the copper (atacamite) with which they made knives and other implements.

IN the New York City building at the Panama-Pacific Exposition, the gardens, libraries and museums of New York will have a booth some twenty-four feet long at the left of the entrance, with interior and exterior wall space for the display of photographs. Each institution of the city has been allotted approximately ninety square feet of surface.

AT a meeting of members of the Lister Institute, London, under the presidency of Sir Henry Roscoe, held on November 18, a proposal to authorize the governing body to effect an amalgamation with the Committee for Medical Research, established under the National Health Insurance Act, 1911, with clauses provisionally agreed to by the treasury was rejected.

AT the recent meeting of the National Association of State Universities, in Washington, there were five municipal universities, institutions directly controlled and supported by cities, represented. President Charles William Dabney made the opening address on "The Municipal University." At the close of the meeting President Wheeler, of the University of California, addressed representatives of urban universities on the importance of their service to American institutions. An association to be called the Association of Urban Universities was then founded and all institutions cooperating with cities and training for public service were invited to become members. The purposes of the association were announced to be the study of the problem of the city in its broadest sense, and the training of men and women to serve the state. Dr. Dabney, of the University of Cincinnati, was elected president; Dean Everett W. Lord, of Boston University, vice-president, and Dr. Walter E. Clark, of the College of the City of New York, secretary.

THE twenty-seventh annual meeting of the American Economic Association will be held at Princeton, N. J., from December 28 to 31. The American Statistical Association and the American Sociological Society will hold their annual meetings at the same time and place. Several joint sessions will be held. The first session is to be a joint meeting addressed by the presidents of the three associations—Messrs. John H. Gray, John Koren and Edward A. Ross. The morning session on December 29 is to be on "Speculation on Stock Exchanges and Public Regulation of the Exchanges." Papers will be presented by Messrs. Samuel Untermyer and Henry C. Emery. The afternoon session on December 29 will be on "Market Distribution." The morning session on December 30 will be a joint meeting with the American Statistical Association to discuss "The Statistical Work of the United States Government"; the after-

noon session will be devoted to "The Relation of Education to Industrial Efficiency" and "The Effect of Inheritance and Income Taxes on the Distribution of Wealth." The concluding session on December 31 will be a joint meeting with the American Sociological Society on "The Public Regulation of Wages."

At a meeting of Yale University men interested in engineering at the Yale Club, on December 4, a constitution was adopted forming a Yale Engineering Association. Discussion of this project has been under way for a year, and a committee, consisting of E. G. Williams, '87S.; Calvert Townley, '86S.; Bradley Stoughton, '93S.; W. C. Tucker, '88S., and Professor L. P. Breckenridge, '81S., of the Scientific School, has been at work drawing up the organization papers. The main purpose of the association will be "to advance the interests of engineering education at Yale and to promote the better acquaintance and fellowship of Yale engineers."

The *Bulletin* of the American Geographical Society states that for two years past the Department of Historical Research at the Carnegie Institution has given a considerable amount of time to planning an atlas of the historical geography of the United States and collecting materials for its construction. Several specialists, including Professor Frank H. Hodder, of the University of Kansas; Professor O. G. Libby, of the University of North Dakota; Professor Max Farrand, of Yale University, and Professor Jesse S. Reeves, of the University of Michigan, each proficient in one or more subjects to be covered by the atlas, have been called to Washington to conduct investigations for the proposed work. The department of historical research wishes to make the atlas of the greatest possible use to the teachers and writers of American history and is seeking all the helpful cooperation that can be secured. According to present plans the completed atlas, exclusive of text, will contain 200 pages measuring about 22 by 14 inches. The largest maps will be approximately full-page maps, many others will be about one fourth that size and many still smaller. The area covered will be generally the whole or a part of continental United States. It may occasionally be found desirable, however, to represent our detached possessions, adjacent parts of Canada and Mexico, the West Indies and parts of the north Atlantic and north Pacific oceans. Excepting maps illustrating the geology of the country and its early aborigines, all the maps will fall within the period from the discovery of America in 1492 to the present time. The general headings are expected to include physical geography, aborigines, early maps of America, routes of explorers and colonizers, boundaries and divisions, industrial and social maps, and political, city and military maps. A considerable portion of the atlas will be devoted to political statistics, which will be treated somewhat after the method of Professor Turner and his students. It is to be hoped that the specialists in charge will have all the collaboration that can add to the value of the proposed atlas.

A conference of Pacific coast horticulturists was called by Governor West, of Oregon, to meet at the Agricultural College early in December to secure better and uniform fruit inspection throughout the western fruit-growing states. After hearing reports and recommendations from the horticultural commissioners of Oregon, California and Washington, a joint committee of producers and distributors was appointed to prepare a bill embodying the features endorsed by the conference, to be presented to the state legislatures with the recommendation that it be enacted into law. The joint committee called in as advisory members Professor H. F. Wilson and Professor H. S. Jackson, entomologist and plant pathologist, respectively, of the Oregon Station. The measure as framed by the committee provides effective inspection both within the states and from other states, with as little restriction as is consistent with efficiency. The ultimate aim of the conference is to secure uniform horticultural laws throughout the entire country.

UNIVERSITY AND EDUCATIONAL NEWS

Two gifts of $100,000 each for the development of a graduate course in preparation for

business and business administration at the Sheffield Scientific School of Yale University, are announced. The donors are Frederick W. Vanderbilt, of the class of 1876, S., and a graduate of the class of 1887, S., whose name is not made public. The new course will be for one year, and, if possible, two years. It is expected that it will be open to students at the beginning of the next academic year.

A GIFT of $10,000 to Smith College has been made by Mr. and Mrs. A. J. White, of Brooklyn. Half of the money is to be applied toward payment for recent improvements on the Lyman Plant House. The remainder will constitute a permanent endowment fund for repairs to the house, purchase of new materials, and encouragement of botanical study.

A BEQUEST of $10,000 to St. Lawrence University at Canton, N. Y., is made under the will of Mrs. Kate A. L. Chapin, of Meriden, Conn.

AT its last session, the council of the Université de Paris unanimously resolved that Belgian students who before the war had been matriculated in one of the universities of their own country might become matriculated in the schools of the Université de Paris without having to pay the matriculation, inscription and library fees. Young Belgians from the Belgian establishments of secondary education will likewise be received if they fulfill the conditions exacted by the Belgian universities. In default of diplomas and certificates, the young people may prove their qualifications by such means as are possible, for instance, certificates of French or Belgian diplomatic or consular agents.

PROFESSOR and Mrs. Frederic S. Lee have given to Columbia University the sum of $20,000 to establish a fund for the use of the department of physiology. It is intended that for the present the income shall be used for the maintenance of the library of the department. The university is about to acquire the valuable collection of books belonging to the late Professor John G. Curtis and consisting of ancient and medieval works on the history of physiology.

DR. ROBERT BENNETT BEAN, of the department of anatomy in Tulane University, has been advanced from the rank of associate professor of anatomy to that of professor of gross anatomy in the department of anatomy, and Dr. Sidney S. Schochet and Mr. Charles W. Barrier have been appointed instructors in anatomy.

DISCUSSION AND CORRESPONDENCE

TEACHING AND RESEARCH

THE suggestive article by Professor Cattell in SCIENCE of October 30, p. 628, leads me to offer a few observations growing out of my own experience. One who is wholly a teacher tends to organize his work on a more or less permanent basis, with definite limitations. If he possesses good natural ability, he becomes very efficient, teaching clearly and logically what appear to him to be the more important things. He tends more and more to fixed opinions, and to arbitrary divisions between the things which should be known and those which need not be known. Such a man will be tremendously indignant because X does not know a, but feel no shame on account of his own ignorance of the analogous facts b, c, etc.

One who is primarily interested in research finds his mind much occupied with various trains of thought, and his interest tends to center about *uncertainties* rather than *certainties*. Even as he teaches, things assume new aspects to his mind. Much has been made of the saying that Kelvin made discoveries while lecturing, but (in a small way) this is probably a common experience.

The teacher who does no research tends to become increasingly confident of his own knowledge, and conveys this feeling to his class. One who is primarily an investigator, unless he works in a very small field which he has thoroughly in hand, is continually reminded of his own limitations and of the vastness of the unknown. He is humbled by the mistakes he can not help making, and feels and appears more ignorant.

I have tried to define extreme cases; most of us are blends or mosaics of the two types. It must be admitted, I think, that when a teacher is keenly interested in research, his teaching suffers in some respects. It gains in others, and the question is, how to find the optimum condition of affairs. We seem to be attacking the old problem of progress. We are reproducing on a minute scale the phenomena of evolution. The absence of progress and excessive progress are alike detrimental, and there is a shifting optimum between. My personal opinion, which tends to grow stronger with time, is that our universities mostly err on the side of conservatism and dogmatism, so that additional emphasis on progressive policies becomes desirable. By a sort of paradox, conservative teachers with rigid ideas are frequently undecided or indifferent as to the merits of the systems they expound, rather priding themselves on their academic impartiality. On the other hand, progressive thinkers will be filled with particular ideas at particular times, and will then appear very confident; thus, superficially, our definitions may seem reversed. In reality, the indecision of the conservative is due to the limitations of his field, and is quite different, psychologically, from the indecision of a man who is ardently seeking a solution which still evades him.

There is, of course, another matter to be considered. Granting that a research man, with his necessary limitations, makes a better teacher than one who is only a teacher, what if he loses interest in his teaching? Many will remember instances of this sort, and it is customary to put the whole blame on the man who has thus failed. Is it not possible that the loss of interest is sometimes accelerated by the indifference of those who do not wish to receive the only sort of thing the man can give? There is so much to do in this world that among the numerous possible activities presenting themselves there is a sort of survival of the fittest. No one is justified in "wasting his sweetness on the desert air," if he can help it. The problem then becomes one of creating an atmosphere in which good teaching can flourish, as well as securing good teachers.

On the whole, it appears that we can not have every good thing at once. It is for each department and man to seek an optimum which will certainly differ according to times and circumstances. It may, however, be worth while to try to understand the psychology of each situation as it arises.

T. D. A. Cockerell
University of Colorado,
November 16, 1914

A NOTE ON APPARATUS REPAIR

To the Editor of Science: Doubtless there are many who like the writer have met with accidents where a fused-in-platinum electrode has broken off at the very surface of the glass. Such a thing occurred while setting up Hoffman's apparatus for electrolysis.

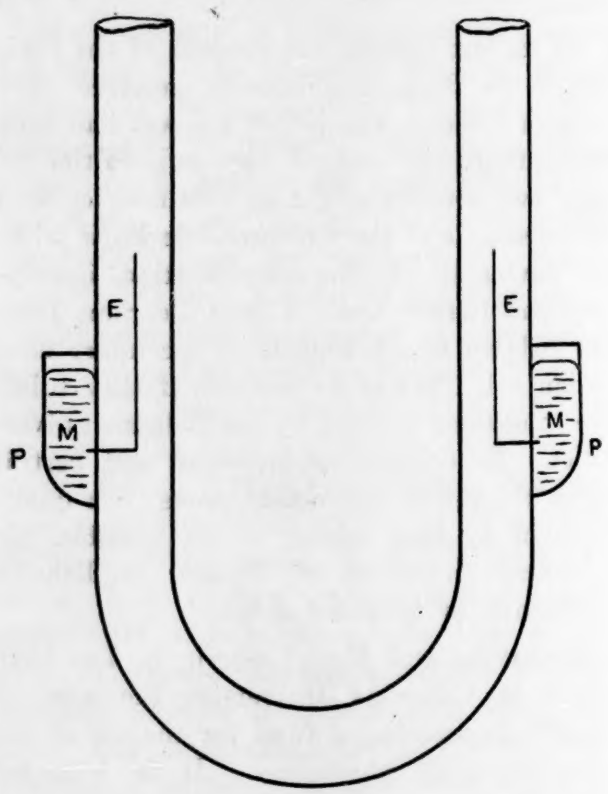

Fig. 1.

In order to repair it the writer took a piece of chamois skin cut to an appropriate size and shape, formed it into a little sack and fixed it with sealing wax to the outer wall of the vertical tube. This sack was so placed that when

nearly filled with mercury the broken end of the platinum wire was immersed in the liquid. To make a connection with the battery circuit it was simply necessary to insert a connecting wire into the sack containing the mercury. This makeshift has worked splendidly many times and there seems no reason why it should not work indefinitely. The sketch shows the arrangement above noted. *E,E,* are electrodes, *M,M,* mercury, *P,P,* the pockets.

The thought occurs to the writer that it would be possible to place on certain pieces of glass apparatus designed with fused-in-platinum wires some sort of glass pocket, the function of which would be the same as the leather pocket above mentioned. It is obvious that this arrangement would do away entirely with the risk of accident.

In the case of much glass apparatus where the electrodes are inserted through the glass the outer terminals are metal rings somewhat securely fixed in place—for example as in vacuum tubes. Even in electrolytic apparatus such a scheme may be used at times. Yet, while that arrangement is certainly an improvement over the projecting-out piece of platinum wire, it seems that the above scheme would lend itself to even more careless and safe handling.

It is further suggested that the same idea might be used on certain forms of vacuum tubes.

G. B. O.

COLBY COLLEGE

THE TENTERTON STEEPLE AND THE GOODWIN SANDS

ON reading the reference to the Tenterton (Tenterden) Steeple and the Goodwin Sands in the article on "Heredity and Environment" by Mr. Henry Leffman,[1] I wondered whether the reference in question would be generally understood. I did not think so, and in order to test the matter I stated the reference and its connection in a meeting of some seventy high-school teachers, among whom were many A.B.'s, several A.M.'s and a sprinkling of Ph.D.'s. I asked those who understood the reference to raise a hand. The result was even more meager than I had anticipated—not a single hand went up.

[1] SCIENCE, October 23, 1914, pp. 593–594.

Although most readers of the article referred to may have reached the conclusion which the author evidently took for granted they should reach, yet because the Goodwin Sands have recently been referred to in the war news from Dover (England)—the Sands are in that vicinity—and further because there may be some readers of SCIENCE who are still in the dark about the relation between the "Sands" and the "Steeple," therefore I thought that a brief account of the origin of the incident might not be altogether unprofitable.

In a "Compendium of English Literature" by Charles D. Cleveland, published at Philadelphia by J. A. Bancroft & Co., in 1869, may be found selections from the more prominent authors from Sir John Mandeville to William Cowper. On page 65 of this compendium a biographical sketch of Hugh Latimer is found, and following that are a few selections from his writings. One of the selections (p. 67) is entitled "Cause and Effect," and reads in part, as follows:

> Here is now an argument against the preachers. Here was preaching against covetousness all the last year, and the next summer followed rebellion. *Ergo,* preaching against covetousness was the cause of the rebellion—a goodly argument. Here now I remember an argument of master More's which he bringeth in a book that he made against Bilney; and here by the way I will tell you a merry toy.
>
> Master More was once sent in commission into Kent, to help to try out (if it might be) what was the cause of the Goodwin Sands, and the shelf that stopped up Sandwich haven. Thither cometh Master More, and calleth the country afore him, such as were thought to be men of experience, and men that could of likelihood best certify him of that matter concerning the stopping of Sandwich haven. Among others came in before him an old man, with a white head, and one that was thought to be little less than a hundred years old. . . . So master More . . . said: "Father (said he), tell me, if you can, what is the cause of this great arising of the sands and shelves about this haven, . . . [so] that no ships can arrive here? . . . ye of likelihood can say most to it, or at leastwise,

more than any man here." . . . "Yea, forsooth, good master (quoth this old man), for I am well nigh a hundred years old. . . . [and] forsooth, sir, (quoth he), I am an old man; I think that the Tenterton-steeple is the Cause of the Goodwin Sands. For I am an old man, sir, (quoth he), and I may remember the building of the Tenterton-steeple, and I may remember when there was no steeple at all there. And before that Tenterton-steeple was in building, there was no manner of speaking of any flats or sands that stopped the haven, and therefore I think that the Tenterton-steeple is the cause of the destroying and decay of Sandwich haven." And so to my purpose, is preaching God's word the cause of rebellion, as the Tenterton-steeple was cause that Sandwich haven was decayed.

MAXIMILIAN BRAAM

HUGHES HIGH SCHOOL,
CINCINNATI

SCIENTIFIC BOOKS

Roger Bacon. Essays contributed by various writers on the occasion of the commemoration of the seventh centenary of his birth. Collected and edited by A. G. LITTLE. Oxford University Press, Oxford. 1914. Pp. viii + 426.

American universities and American scholars are fortunate in the undisputed right to celebrate the anniversaries of any of the great teachers that the world has known. Oxford has the first claim to commemorate the name and fame of Roger Bacon, for there the "learned doctor" spent many years, both as teacher and student. The committee on the commemoration of the seventh centenary of Roger Bacon's birth has erected a statue of Roger Bacon, by Mr. Hope Pinker, in the University Museum at Oxford, has issued the volume of memorial essays under discussion, and has raised funds for the publication of certain unpublished works of the great Franciscan. In America Columbia University has celebrated this anniversary with appropriate exercises, including a pageant; at the University of Michigan the Research Club devoted its annual memorial meeting to public exercises on Roger Bacon, with papers by Professors Dow, Lloyd, Guthe and Tatlock, discussing the life and times, the philosophy, the scientific activity and the relation to magic and astrology of Roger Bacon. The *Open Court Magazine* dedicated the issue of August, 1914, entirely to Bacon, and foreign journals, such as the *Revue des deux Monds,* have taken this time to discuss the contributions to various fields made by Bacon.

Simply the titles of the essays in the present volume, and the list of contributors, pay such a high tribute to the intellectual activity of Roger Bacon that it seems desirable to present the list of contents:

I. Introduction: On Roger Bacon's Life and Works. By A. G. Little, M.A., Lecturer in Paleography in the University of Manchester.

II. Der Einfluss des Robert Grosseteste auf die wissenschaftliche Richtung des Roger Bacon. Von Universitätsprofessor Dr. Ludwig Baur in Tübingen.

III. La Place de Roger Bacon parmi les Philosophes du xiii[e] siècle. Par François Picavet, Secrétaire du Collège de France, Directeur à l'École pratique des Hautes-Études.

IV. Roger Bacon and the Latin Vulgate. By His Eminence Francis Aidan Cardinal Gasquet, D.D., O.S.B., President of the International Commission for the Revision of the Vulgate.

V. Roger Bacon and Philology. By S. A. Hirsch, Ph.D.

VI. The Place of Roger Bacon in the History of Mathematics. By David Eugene Smith, Professor of Mathematics, Teachers College, Columbia University.

VII. Roger Bacon und seine Verdienste um die Optik. Von Geheimer Hofrat Professor Dr. Eilhard Wiedemann in Erlangen.

VIII. Roger Bacons Lehre von der sinnlichen Spezies und vom Sehvorgange. Von Dr. Sebastian Vogl in Passau.

IX. Roger Bacons Art des wissenschaftlichen Arbeitens, dargestellt nach seiner Schrift "De Speculis." Von Dr. J. Würschmidt in Erlangen.

X. Roger Bacon et l'Horreur du Vide. Par Pierre Duhem, Membre de l'Institut de France, Professeur à l'Université de Bordeaux.

XI. Roger Bacon: His Relations to Alchemy and Chemistry. By M. M. Pattison Muir, M.A., Fellow, and formerly Prælector in Chemistry, of Gonville and Caius College, Cambridge.

XII. Roger Bacon and Gunpowder. By Lieutenant-Colonel H. W. L. Hime, (late) Royal Artillery.

XIII. Roger Bacon and Medicine. By E. Withington, M.A., M.B.

XIV. Roger Bacon in English Literature. By Sir John Edwin Sandys, Litt.D., LL.D., F.B.A., F.R.S.L., Public Orator in the University of Cambridge.

Appendix. Roger Bacon's Works, with references to the MSS. and Printed Editions. By A. G. Little.

A critical discussion of these fourteen essays is obviously beyond the power of any one individual. However, any scholar in any field will find much that is of interest and even of profit, in intellectual stimulus, in all of these essays. Roger Bacon came at a time when the world of the Middle Ages was reawakening. The learning of the Greeks and the Byzantines, the learning of the Jews, and the learning of the Arabs, were made accessible to the scholars of that time by the numerous translators of the eleventh, twelfth and thirteenth centuries; although Roger Bacon had much to say about the inaccuracy of many of the translations with which his readers were familiar, the fact remains that to the authors of these works is due in large measure the revival of learning which was in full swing in the thirteenth century. It need then occasion no surprise that much of the material which is found in the writings of Roger Bacon may be found in the writings of Greek, Jewish and particularly Arabic scholars who preceded him. So, too, as Baur points out, the teachings of Bacon may frequently be traced to the influence of Robert Grosseteste, the great Bishop of Lincoln and a scholar entirely of the type of Bacon. Nor does this dependence upon earlier writers diminish the importance and significance of Bacon's work. There are now and then those geniuses who proceed far in advance of the main body of scholars; but their work in a large measure is lost unless, in some way, the great mass of scholars can arrive at the point to which the advance guard has attained. Only in this way can we understand how it happened that the work of Archimedes, so much in advance of its age, exerted so little influence for fifteen hundred years. Archimedes lacked continuators and those who could popularize his work.

The modern point of view in many discussions is most striking. Bacon would have the ancient languages studied for a more complete and precise understanding of the Scriptures; he urged the study of modern languages in order to promote trade, to facilitate political relationships, and for the conservation of peace. The accounts of the great travellers of his time, and the geography of the world, were of intense interest to him. His interest in mechanical discoveries, and a somewhat prophetic vision, are evident in his statement: "I have not seen a flying machine, and I do not know any one who has seen one; but I know a wise man who has thought out the principle of the thing."

This work can be commended in its entirety to all students of science. The volume is interesting and instructive in many ways. Any one who reads the work through will have obtained a very clear idea of the intellectual activity, and the life of the students in the Middle Ages, as well as a renewed appreciation of the underlying unity of all learning.

The first three essays in the work are written in English, German and French, respectively; the following three are written by a Cardinal of the Roman Church, a Jew and an American. May this kind of international cooperation speedily return, and wipe out the memory of these terrible days when gunpowder, possibly invented by Roger Bacon and used by him as an amusement for children, is being used by civilized man for the destruction of his fellows.

LOUIS C. KARPINSKI
UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

The Birds of the Latin Poets. By Ernest Whitney Martin. Leland Stanford Junior University Publications. University Series. Stanford University, California. Published by the University. 1914. Pp. 260.

This, the latest contribution to the literary side of ornithology, covers a virgin field. In "The Birds of the Latin Poets" Professor Martin has attempted to bring together from the Roman poetical writers their passages which mention birds of any particular kind; and an examination of his text and appended bibliography shows how admirably he has succeeded. Very wisely no attempt has been made to include either prose passages or references to birds in general.

After a brief preface these quotations form the major portion of the book, in which the arrangement is conveniently alphabetical by names of birds, from *Acalanthis* to *Vultur.* Under the Latin name or names of each bird is given a Greek equivalent or equivalents, the English names, and the scientific name or names, the last in many cases not more than generic. Comment on the use of two or more Latin names for the same bird is sometimes added, together with various notes and explanations, including many mythological references. There are mentioned also the conspicuous avian parallels of American poetical literature, these birds being not the scientific equivalents, but, as our author very well puts it, "the birds which have aroused similar reactions in the feelings of their poetic observers." A list of American poems thus pertinent to the bird in hand is given when possible; also a list of Latin epithets, some of the latter being especially interesting, as, for instance, in the case of *Aquila.* Then follow the various Latin quotations arranged under different topics, and liberally interspersed with the author's comments and with extracts in English, mostly from American poets. These passages for each bird occupy from half a page, or even less, to as many as 17 pages. Not counting synonyms entered for convenience of reference, 70 different birds are thus treated, among which, as of particular interest, may be mentioned *Anser, Aquila, Cycnus, Hirundo* and *Luscinia.*

Following this treatment of individual birds are four "Notes" of several pages each—virtual appendices—on "The Spring Migration and Spring Song"; "The Fall Migration and the Fall Song"; "The Hibernating of Birds"; and "Ruscinia." Under the first of these headings quotations are given to show the attitude of both American and Latin poets toward the spring movements of birds; and under the second caption similar treatment is accorded the fall migration. The mythical hibernation of birds is considered in like manner in "Note III." The last of these "notes" is devoted to a discussion of the origin and identification of the "ruscinia," and of the application of this name to the nightingale. The author's conclusions regarding this obscure question come probably as near the true solution as is now possible.

A "Bibliography of the Principal Literature Consulted" and an index of all the citations from Latin authors complete the book.

This treatise has been written, and its numberless quotations collected, for the purpose of showing the Roman attitude toward bird life so far as it is depicted by the Latin poets. The result is thus much more than a mere collection of quotations, and really gives an insight such as perhaps we could obtain in no other way. With our present-day knowledge of birds it is somewhat difficult for us to realize how meager and vague, when the Latin poets lived and wrote, was even the scientific information regarding bird life, and how interwoven and bound up with tradition, mythology and augury were even the common facts of every-day observation; a condition which renders difficult, indeed, often impossible, the very identification of the birds that they had in mind and at the tip of the pen. By reason of this we ought the more to appreciate the additional light that comes from researches such as these of Professor Martin's. Of notable interest is the Roman attitude toward the song of birds, as disclosed by the poets. This is, as our author expresses it: "that they nearly always felt a tone of sadness in the songs of their favorite song birds, where we are inclined

to feel joy and ecstacy." This, our author, with much reason, holds, is due to the ancient prevalent belief in metamorphosis, through which the Roman thought of his birds not simply as birds, but also as human beings in changed form. Another observation worthy of mention, to which our author is led by his study of the writings of American poets, is that in the latter is found much more traditional Greek and Latin bird lore than the ordinary reader realizes.

It is unfortunate, though perhaps unavoidable, that of a number of the birds treated, identifications more specific were not made. Moreover, while we do not forget that the purpose of the book is primarily not scientific, but literary, we are of the opinion that its literary flavor would not have suffered from the use of proper modern scientific names instead of the antiquated terms that appear under many cf the species. Any well-informed ornithologist could have furnished these. Less excusable is the statement (page 242) that the nightingale is not a thrush, but a member of the "silvidæ." A good index of bird names would have aided much in finding references scattered through the text.

Few of us, however, can fully appreciate the great amount of research involved in the task that the author has set for himself; and we owe him a debt of gratitude for having put before us in such readable form the results of his industry; and for having produced a treatise that will be interesting and profitable alike to classicist, litterateur, and ornithologist. It furthermore impresses us anew with the thought that in all phases of ornithological study there are the same endless possibilities that these lines of the poet suggest:

Quis volucrum species numeret, quis nomina discat?
Mille avium cantus, vocum discrimina mille.

HARRY C. OBERHOLSER

A Montane Rain Forest. A Contribution to the Physiological Plant Geography of Jamaica. By FORREST SHREVE. Carnegie Institution of Washington, Publication No. 199.

This admirable presentation of the results of eleven months' study of the forests of the Jamaican mountains should demonstrate the value to American botany of a laboratory in the primeval forest of the western tropics. It ought also to prove the pioneer of a whole series of exact distributional and experimental studies of American tropical vegetation.

The main ridge of the Blue Mountains, which varies from 5,000 to 7,428 feet in height, lies directly across the path of the northeast trade winds. In consequence of this the climate of the northern, or windward side is fog-drenched and constantly humid, with a rainfall of 160 inches. Two miles south of the ridge, however, the precipitation is but 105 inches, the percentage of sunshine is far higher and hence the climate is decidedly warmer and less humid. The whole region is frostless. The annual range of temperature is about 42° Fahrenheit, and the daily range close to 12°.

The flora of the rain forest is less varied than that of the neighboring tropical lowlands. The composition of the flora is rather less like that of these lowlands than that of a temperate forest. A list is given of the higher plants, which is not intended to be complete, but does embrace the more characteristic species. It includes 93 pteridophytes and 187 seed-plants.

The vegetation of the untouched rain-forest is dominated by a nearly continuous covering of trees, very few of which get to be more than 50 feet high and 2½ feet in diameter before being undermined by the rapid erosion characteristic of the region. On the ridges and higher slopes the trees are reduced to 15 or 20 feet in height. The floor of the forest, especially of the windward slopes and ravines, supports many shrubs and has an abundant carpet of herbaceous mosses, ferns and seed-plants, while numerous epiphytic mosses, ferns, orchids and bromeliads stick to the branches of the trees and lianes often overspread their tops. On the leeward slopes, and on the ridges of both sides trees are more scattered, the herbaceous ground vegetation is sparse, but thickets of shrubs or of climbing ferns and

grasses cover the soil between the trees. This difference in the types of plant covering on the windward and leeward sides is the most striking feature of the distribution of the vegetation of these mountains. A comparison of the vegetation of a valley bottom with that of its own higher bounding slopes, even on the beclouded windward side, shows a difference of the same sort as that just mentioned, though somewhat less marked.

Detailed instrumental measurements of the physical characteristics of several selected habitats were made by Shreve, between October, 1905, and June, 1906. These studies of the climate, in the valleys and on the ridges and at the top of the forest canopy as well as on its floor, together with his inquiry into the transpiration capacity of typical rain-forest plants, are perhaps the most unique features of his contribution. The habitat in which the climatic peculiarities of the rain-forest are most accentuated, as was demonstrated by the aid of the air and soil thermographs, the hygrometer and atmometer, is the floor of the windward ravines. Here soil moisture is abundant, the leaves are dripping wet with rain or fog for weeks together. The humidity is constantly high; the rate of transpiration is very low and the light filtering through the screen of foliage and of cloud is faint even at midday. On the slopes, and especially on the ridges, of both windward and leeward sides of the mountains, where air currents and sunlight have freer access, the soil is still moist, but the leaves are less often covered with water drops, and measurement shows that the humidity of the air is less, the rate of transpiration is higher and there is a somewhat greater daily range of temperature. These climatic differences, taken together with the characteristic differences in the vegetation of the two sides of the range, make it clear that the general distribution of the vegetation here is controlled primarily by the moisture content of the air rather than by that of the soil. The latter is probably adequate in all but a few restricted locations.

One very interesting feature of the seasonal activity of the rain-forest trees is that while certain of them vegetate actively throughout the year, others growing right beside them show a well-marked winter rest. Most of the former species are allied with the lowland tropical forms, while the latter are allied rather with north temperate genera.

Most plants of this montane region grow quite slowly, probably in consequence of the moderate temperatures, a low transpiration rate and the often weak light. The uncoiling leaves of certain ferns show the most rapid growth observed.

The rate of transpiration was studied in 8 or 10 species. One rather unlooked for result was that the rate of transpiration for these plants, *under the conditions prevailing in the rain-forest,* is not *very* unlike that found for many Arizona plants *when growing under desert conditions.* As a matter of fact the desert plant, in spite of its highly protected surface, loses more water per square centimeter of surface, in its native habitat, than the plant of the rain-forest when growing in its home.

One other interesting conclusion of the author from this comparison of rain-forest plants and desert plants is that the continuous extreme humidity, the low temperature and weak illumination give conditions approximately as unfavorable to plant growth as are the opposite extreme conditions of arid regions. The tropical lowlands and the moist temperate regions are regarded as the homes of the most luxuriant and most varied floras of the earth, and the places of origin of new structures and new species.

Duncan S. Johnson

Engineering Geology. By Heinrich Ries and Thomas L. Watson. New York, John Wiley & Sons. Octavo, bound in cloth. 672 pages.

This volume fills a special field in which it has no rival. It is arranged particularly for the use of the student of civil engineering, but the full treatment of many subjects and the extensive lists of standard papers will make it also a valuable reference work for engineering libraries. In many engineering

schools the curricula of the students of civil engineering provide one term only for geology. The student is expected to master the principles of geology and to find the applications in that brief time without any previous training in physiography, mineralogy, petrology or paleontology. It is obviously a difficult task to arrange the material so that the groundwork of principles is made clear in the short time allotted for the study, and applications emphasized sufficiently to make the study of much practical value. This difficulty is happily met in this volume by brief and concise statements of principles followed by ample and well-chosen illustrations.

The book is well arranged for the mature and serious-minded beginner who wishes to get the maximum of material in a short time. The more advanced student will find also many applications of geology brought from widely scattered sources and some which are not treated elsewhere. Separate chapters are devoted to rock minerals, rocks, structural geology and metamorphism, rock weathering and soils, rivers, lakes, wave action, underground waters, landslides, glacial deposits, cements, clays, coal, petroleum and gas, road material, and ore deposits. The mechanical features of the work are excellent; particularly noteworthy are the clearly executed photographs and line drawings.

W. H. EMMONS

MINNEAPOLIS

Die Umwelt des Lebens. Eine physikalisch-chemische Untersuchung über die Eignung des Anorganischen für die Bedürfnisse des Organischen. Von LAWRENCE J. HENDERSON; übersetzt von R. BERNSTEIN. Wiesbaden, J. F. Bergmann. 1914.

This volume is the German translation of the author's book, "The Fitness of the Environment," recently reviewed in these columns.[1] There are a few additional features; the table of contents contains a very complete and convenient summary of the whole book, important sentences or paragraphs are italicized, and a brief final chapter has been added; there is also an interesting and apposite quotation from du Bois-Reymond in a footnote on page 161; and the subject-index has been omitted. Otherwise the book remains unchanged.

In his final chapter the author calls attention to the existence of "a hitherto unrecognized order among the properties of the chemical elements,"—referring to the remarkable manner in which certain fundamental properties, which have largely conditioned the course taken by the evolutionary process, are distributed among the elements. These properties, far from being distributed with approximate uniformity—as the periodic system might lead us to expect—attain strongly marked maxima, or are, so to speak, concentrated, in relatively few elements, which at the same time are among the most abundant and widespread, namely: carbon, hydrogen and oxygen. "As a result of this fact there arise certain characteristics of the cosmic process which could not otherwise occur:" the implication is that at the outset of cosmic evolution there were present in advance all of the conditions needed for the development of physico-chemical systems having *vital* peculiarities, *i. e.*, possessing the complexity, activity and stability in a changing environment which are essential to living organisms. The properties of these three elements—and of no others—show a most detailed "fitness" for the production of just such systems. If, therefore, the main outcome of evolution be regarded as the development of living organisms, "the biologist may rightly regard the universe in its very essence as biocentric."

The volume is attractively printed and is dedicated to Karl Spiro.

R. S. L.

[1] SCIENCE, N. S., 1913, p. 337.

THE OXIDATION OF NITROGEN AND HOW CHEAP NITRATES WOULD REVOLUTIONIZE OUR ECONOMIC LIFE

How is Atmospheric Nitrogen Oxidized?

IT is not many years ago (1898) that Sir William Crookes sounded the note of alarm

concerning the possibility of a future famine in the world's supply of nitrates and other nitrogen compounds. At that time the supply of these salts was largely confined to certain beds of guano and Chile saltpeter. During the past few years most important advances have been made in our knowledge of the fixation of atmospheric nitrogen, and some of the processes have been placed upon a purely commercial basis.

In addition to drawing on the air directly for nitrogen it has been found that large amounts of ammonia and other nitrogen compounds may be obtained as by-products from coal and peat in connection with the manufacture of coke, illuminating gas and the metallurgy of iron. The treatment of various shales, peats, silts and organic refuse often yields nitrogen compounds. The nitrogen in these substances has probably been derived from the atmosphere by one or more of the processes which will now be described.

The amount of nitrogen that enters into the plant and animal growth ("nomadic" nitrogen) has been estimated to be about 20 gm. per square yard of land. Part of this is being constantly changed into nitrogen gas by the action of nitrifying and dentrifying bacteria. In nature an equilibrium is maintained between the action of these bacteria and the oxidization of nitrogen in the air by means of electrical discharges and the action of plants, such as clover. The natural processes of fixing nitrogen are therefore electrical and by the action of bacteria in the legume crops of clover and similar plants. In former geological times certain nitride and other chemical compounds may have been formed directly with the air nitrogen, but it is doubtful if any such direct chemical reactions take place at present.

The natural oxidation of nitrogen by electrical discharges takes place during electrical storms, the aurora discharges at high levels and possibly in a slight degree in the bombardment of the higher strata of air by cathode and similar rays, ultraviolet light, and possibly by other radiations. The disintegration of radium and thorium products yields a small amount of oxides of nitrogen. It has been estimated that in this way about 100,000,000 tons of fixed nitrogen is carried to the earth every year by rain water.

The other natural method of fixing atmospheric nitrogen is that of the action of bacteria in the root nodules of the clovers, peas, vetches and other legumes. The chemical processes are very complicated and are at present unknown. This process is, however, of tremendous importance to the farmer and is probably the cheapest method now known of obtaining nitrogen as a fertilizer. This method is, however, quite expensive in that clover seed is expensive and the raising of a crop of clover requires attention, time and the exclusion of other crops. On the poor soils where humus is the most needed it is found very difficult to get clover to grow. Restoration of fertility to run down soils by this method is therefore slow and expensive.

The commercial methods of manufacturing nitrogen salts includes the cyanamide process, the direct synthesis of ammonia, the various nitride processes of making ammonia and the electrical methods of oxidizing nitrogen.

A process that is being used commercially is that of treating calcium carbide with nitrogen gas, thus yielding cyanamide which itself makes a good fertilizer. Although the reactions are known to be complex, they may be represented as regards the end products as follows:

$$CaO + 3\ C \rightleftharpoons CaC_2 + CO,$$
$$CaC_2 + N_2 \rightarrow CaCN_2 + C.$$

The latter reaction begins at 1000° C. or at even lower temperatures. The N_2 may be prepared by the Linde process or by passing air over hot copper. According to Caro the energy consumption for fixing one ton of nitrogen (including making the CaC_2, azotising, machine driving, grinding, charging, air liquefaction) is less than 3 H.P. years.

The direct combination of nitrogen and hydrogen into ammonia is very successful when done on a small scale with pure gases but, so far as is generally known, this process is not being worked on a large scale. A Ger-

man company, however, is planning to make large quantities of ammonia by this process.

The nitride (including the Serpek) processes have not as yet proven to be successful from the commercial point of view. It is quite possible that these methods may be used in connection with the manufacture of aluminium and other metals with which these chemical methods are intimately connected.

The Electrical Methods for Fixing Nitrogen

Several electrical methods are used for oxidizing the nitrogen of the air into nitric acid and various salts of nitrogen. These methods all produce chemical reactions between gaseous oxygen and nitrogen in intense electric fields. Potential differences of thousands of volts are used and in the arc methods large currents and high temperatures accompany the use of intense electric fields. In all these methods the aim is to have the electrical discharge take place in the gaseous oxygen and nitrogen and to eliminate as much as possible the effect of the metallic electrodes. Large arcs are therefore necessary when the electric current is large. In the Birkeland-Eyde method the arc is drawn out by a magnet; in the Schönherr process by a helical current of gas and in the Pauling process by horn electrodes and currents of gas. In the author's method a corona current is used and this seems to give the most perfect type of a purely gaseous discharge.

The various electrical processes give about the same order of efficiency when this is measured by the number of grams of nitric acid produced per kilowatt hour of consumption of electrical energy. About 60 to 80 gm. of nitric acid are formed per hour per kilowatt of electrical energy.

The Complexity of Chemical Reactions

Although single atoms, ions and possibly molecules have been isolated, the condition under which the isolation takes place is entirely unique, the particles traveling with a very great velocity. In general chemical reactions will not take place under these conditions in any way that they can be studied individually. Our knowledge of chemical reactions is therefore entirely statistical and our laws apply to a very large number of reactions. There are numerous instances where experimental evidence indicates that the chemical reactions are frequently complex. The speaker's work on the absorption spectra of uranyl and uranous salts indicated the possible existence of various intermediate compounds in chemical reactions in solutions.

In gases chemical reactions are undoubtedly much less complex than they are in solutions, although here the reactions may not be as simple as they are sometimes represented. The spectroscope is beginning to show indications that the light centers are more numerous than the possible number of atom, ion and molecule types. In the case of nitrogen we have various types of line spectra and quite recently Grotrian and Runge[1] have made convincing claims that the so-called cyanogen spectrum is due to nitrogen. (These experimenters worked with large Schönherr arcs about a meter in length.)

Chemical Reaction Centers

Under conditions such as exist in the arc, spark or whenever the temperature is high, many kinds of "centers" may exist. These "centers" may be the sources of light and heat emission or absorption, the ions that show deflections by electric and magnetic fields, and the particles that take part in chemical reactions. It must not necessarily be assumed that the "centers" of the various physical phenomena are the same. They may be widely different.

Among the centers which may exist in arcs and sparks and which have been shown to exist in vacuum tubes are

$$\overset{-}{O}_2,\ \overset{-}{O},\ \overset{+}{O},\ \overset{+}{O}_3,\ \overset{+}{O}_6,\ \overset{++}{O},\ O,\ O_2,$$

$$\overset{++}{N},\ \overset{+}{N},\ \overset{+}{N}_2,\ \overset{+}{N}_3,\ \overset{+++}{N},\ N,\ N_2.$$

Negative electrons also exist in comparatively large numbers.

The formation of nitric oxide in the electric discharge may take place in a large number of

[1] *Phys. Zeit.*, June 1, 1914.

ways. Some of these possible chemical reactions are as follows:

$$O\begin{cases} +N+e+e+e=NO & (1)\\ +N=NO & (2)\\ +\overset{++}{N}_2=NO+N & (3)\\ +\overset{+}{N}+e+e=NO & (4)\\ +\overset{+}{N}+e=NO & (5)\\ +\overset{+}{N}_2+e=NO+N & (6)\\ +\overset{+++}{N}_3+e=NO+N_2 & (7)\end{cases}$$

$$\overset{+}{N}_2+\bar{O}_2=2NO.$$

In the place of O we might place O_2, $\bar{O}_2$, $\bar{O}$, O, O_3, $\overset{+}{O}_6$ and $\overset{++}{O}$. We thus have 56 possible chemical reactions to represent the fixation of nitrogen. No doubt only a few of these reactions actually take place though all are possible, provided all these kinds of ions exist where the oxides of nitrogen are being formed.

The comparative probability of some of these reactions is very small, especially when more than two products take part in the reaction. Since the oxides of nitrogen are apparently not removed from the gases by the electric field, it is probable that the oxide of nitrogen centers are not charged. Hence it follows that reactions which involve the presence of an electron are improbable. The apparent fact that the reaction is "electrical" would indicate that the reactions N_2+O_2 and $N+O$ are not probable. The latter is in accord with the view that active nitrogen consists of N and that N does not take any active part in the formation of oxides of nitrogen.

It seems quite probable therefore that the main reaction that results in the formation of oxides of nitrogen is

$$\overset{+}{N}_2+\bar{O}_2+43000 \text{ calories}=2NO$$

This type of ionization is produced by cathode rays or rapidly moving electrons according to Thomson and others and accordingly this equation would indicate that the oxidization of nitrogen is indirectly due to cathode rays. It may be for this reason that thermionic electron radiations may play an important rôle in the formation of oxides of nitrogen in the various arc processes. In contrast to the above reaction is the reaction resulting in the formation of ozone. Ozone must necessarily be formed under conditions where some O_2 is dissociated.

The above reaction may be only one of several reactions, and under different conditions of pressure and temperature these reactions may be of relatively quite different degrees of importance.

Efficiency of the Nitrogen-fixing Process

We can get some idea of the inefficiency of the present methods of oxidizing nitrogen when we consider that when gram molecular weights of the gases are used one has:

$$N_2+O_2+43{,}000 \text{ calories}=2NO$$

approximately. The amount of energy used in this reaction is therefore about $1.7(10)^{12}$ ergs for about 126 gm. of nitric acid. Assuming 80 gm. of nitric acid to be made per kilowatt hour, we should have an energy consumption of about $5(10)^{13}$ ergs or an efficiency of about 4 per cent.

Nitrogen Fixation and Our Economic Life

The small percentage efficiency of the present methods for oxidization compared with the theoretical efficiency indicate that improvements in the present methods would yield most important results. At the present time sodium nitrate sells for about $45 per ton. If the efficiency of the oxidation method could be increased so that calcium nitrate could be sold for $6 or $8 per ton, it would change our economic life fundamentally. Food products would be greatly decreased in value, real intensive farming could be pursued, suburban homes could easily be made self supporting and "abandoned" farms could be reclaimed. Probably no other one scientific development would so materially add to the material well being of the people as this.

One of the reasons for the high cost of living is the fact that our soil fertility is difficult to maintain. Continued cropping will eventually impoverish the most fertile soils if the crops are not replaced. Cheap nitrogen fertilizers will not only practically restore virgin fertility, but will permit of the continual

removal of crops. In this way the percentage of the crops that can be removed from the soil will be very much greater than under present conditions.

The cheapening of nitrogen fertilizers will permit of doubling, trebling or even more greatly increasing farm crops. In addition to these results cheap nitrogen fertilizers will permit a very much greater percentage of crops to be removed from the farms. Cheap nitrogen fertilizers will also permit of the most intensive farming in the immediate vicinity of industrial centers, thus lessening the time and cost of food distribution.

Surely the problem of nitrogen fixation should appeal to every one interested in the conservation of our resources. Our waterfalls represent an equivalent of nitrogen salt continuously going to waste instead of being used. And surely work of this kind is of greater importance than the building of dreadnaughts or the training of armies.

W. W. STRONG

GARBAGE INCINERATOR AT BARMEN, GERMANY

OWING to the great distance garbage had to be hauled for dumping, the city of Barmen, numbering 172,000 inhabitants, formerly experienced considerable difficulty and inconvenience in disposing of its refuse and waste matter, and finally decided to build a garbage incinerating plant where waste material of all sorts is now burned.

The plant was constructed in 1907 and has given excellent satisfaction in every particular. Not only is all city garbage disposed of in a sanitary way, but from the cremation of this waste two important products are gained, an excellent quality of sand, and electricity.

The city's garbage is collected by an average of twenty wagons, which convey the same to the incinerator and there dump it into large bunkers measuring 4×12 meters (floor space) each. There are seven of these bunkers, each having four trapdoors to receive garbage. From the bunkers the garbage is carried on wheelbarrows to huge funnels which feed the furnaces where the refuse is burned. These funnels have a capacity of 1,200 lbs. each and they are also seven in number. After being filled, a large plug in the center of the funnel is raised and the garbage falls through the opening beneath into the furnace, where it remains for an hour. During the first half hour it rests in the rear of each furnace, where it is ignited by the former deposit, and after burning for half an hour it is brought to the mouth of the furnace by large iron scrapers manipulated by the men serving the fires, and there remains the rest of the hour, cooling and igniting the next deposit from the funnel.

The garbage is then in the form of a glowing, molten mass, called slag, which is removed from the furnaces with long iron hooks and is pulled directly from the grate into metal wheelbarrows, to be then wheeled to the sprinkling quarter, where the redhot slag is cooled by means of water sprinkled thereon for fifteen minutes. Later this process will be simplified, the slag being dipped into reservoirs instead of sprinkled.

After sprinkling, the slag resembles large clinkers and these now come to the crusher where they are broken, ground, and finally reduced to various grades of sand which is used with splendid results for building purposes and for the construction of bricks.

While the garbage itself is thus reduced to sand, the burning of the same gives another very valuable product, namely electricity. This is manufactured in the following manner. The gases resulting from the burning of the garbage have a temperature of from 1,200 to 1,500 degrees Celsius. These gases are conducted to two boilers and there utilized in the production of steam, the latter having a pressure of 10–12 atmospheres. Normally steam of this pressure has a temperature 180° Celsius, but in this case the steam is superheated until its temperature is 300° C., in order that it may be perfectly dry and there may be no danger of its injuring the turbine to which it is now conducted. This steam turbine is a 600 h.p. machine of 3,000 revolutions per minute, and its axle is directly united with that of the dynamo. The capacity of the latter is 400

kilowatts. The steam, consequently, after being heated to 300° Celsius, drives the turbine, and this, in turn, impels the dynamo which makes the electricity. After passing through the turbine, the steam is cooled in a condenser and is then pumped back into the boilers.

The electricity thus manufactured is sold to the municipal electric works (*i. e.,* owned and controlled by the city) at 3½ pfennigs (less than one cent) per kilowatt hour, and the electric works in turn sell the same to the public at 11 pfennigs (2.718 cents) per kilowatt hour. Whenever the garbage incinerator requires electricity for its own use, as for lighting, etc., on Sundays and holidays (ordinarily it furnishes its own electricity), it is obliged to procure this from the municipal works at the regular price of 11 pfennigs. Inasmuch as the garbage cremating plant is also a municipal institution, there eventually is not much advantage or disadvantage either way, as the money belongs to the city under any circumstances, the only difference being in the showing made by the various departments.

The garbage which is thus utilized for the manufacture of commercial products is practically every manner of refuse in existence: rags, paper, household waste, old clothing, and in fact every sort of material usually consigned to the dump heap.

From the garbage brought to the cremating plant 50 per cent. in weight and 30 per cent. in volume goes into the finished product, the sand. That is to say, 100 lbs. of garbage will produce 50 lbs. of sand, while from 100 cubic meters of garbage 30 cubic meters of sand will result.

When once started, the furnaces remain in operation uninterruptedly. The men performing the labor about the plant work in two shifts, from 6 A.M. until 2 P.M. and from 2–10 P.M. At that hour the last charge of garbage is banked so as to burn until the next morning. There is no coal or coke fire of any description, the garbage being its own and only fuel.

The efficiency of the Barmen incinerating plant lies chiefly in the construction of the furnace grates, these being V-shaped, but rounded at the base, and constructed from heavy cast iron. Along the sides of each grate are grooves in which are found minute holes at intervals of about three inches. Through these small holes a strong air current strikes the burning garbage, thus furnishing the necessary draft for combustion and aiding the process of cremation to a considerable extent. In other furnaces these holes are at the bottom of the grates and the wind reaches the fire from below, but it has been found that in this case the application of the air current is a too local one, not reaching the entire burning surface and often merely blowing through the fuel. By the Barmen method the air current, forced into the furnace by powerful pumps, strikes the burning garbage from the sides and from above at an angle, and together with the differing shape of the grate and the grooved sides thereof this method has proved most efficient.

The annual production of the plant amounts to 11,000 tons of slag or clinkers (which are crushed into sand as above explained) from 22,000 tons of garbage, while 1,700,000 kilowatt hours is the annual output in electricity.

Julius Festner,
American Vice and Deputy Consul
American Consulate, Barmen

SPECIAL ARTICLES

A POSSIBLE MENDELIAN EXPLANATION FOR A TYPE OF INHERITANCE APPARENTLY NON-MENDELIAN IN NATURE

As research in genetic problems proceeds, the work of many investigators shows that in all probability certain characters of the organism depend for their visible manifestation in the zygote upon the simultaneous presence of more than one mendelizing factor.

One of the classic examples of this condition is that of the inheritance of the walnut comb in fowls reported by Bateson[1] (1909,

[1] Bateson, W. (1909), "Mendel's Principles of Heredity," Camb. (Eng.) University Press.

p. 60). The chief point of interest in this investigation was the fact that the simultaneous presence in the zygote of R, the factor for rose comb, and P, the factor for pea comb produce an entirely new character, namely, the *walnut comb*. Two walnut-combed birds produced by a cross of pea comb × rose comb gave, when crossed together, an F_2 progeny consisting of walnut, rose, pea and single comb, in a ratio of 9, 3, 3, 1.

A similar result would be obtained if the parents used in the original cross were walnut comb of the formula RRPP and single comb rrpp.

In this last case if we focus our attention on the walnut comb we should see that it recurred in approximately 9 out of 16 of the F_2 progeny.

A *character* dependent solely upon *one* mendelizing factor is present in three fourths of the F_2 progeny. The ratio of those lacking it to those having it being as 1:3. When, however, two factors are needed for the manifestation of a character, as in the case of the walnut comb, the character is lacking in a far greater number of F_2, namely, in 7 out of 16. The ratio of those lacking the character in question to those having it becomes 1:1.3 instead 1:3, as in the case involving only one factor.

If *three factors* are necessary for the manifestation of a given character, the F_2 ratio shows a still greater proportionate increase of animals lacking the character. If the simultaneous presence of factors A, B and C is necessary for the manifestation of a given character, the number showing the character in F_2 may be calculated as follows: F_2 will be made up of 27ABC, 9ABc, 9AbC, 9aBC, 3abC, 3aBc, 3Abc, 1abc. Only the 27 ABC animals will show the character question, and the ratio of those lacking the character to those having it will be as 1.3:1.

An actual cross of this sort is the following: a wild black agouti mouse having the factors B for black, A for agouti and D for intensity was crossed with a dilute brown mouse having the factors b for brown, a for non-agouti and dil for dilution.

F_1 animals were all Aa Bb Ddil, all of them having the character in question, namely, *intense black agouti pigmentation*.

When these F_1 animals are crossed together they should give a ratio of 27 intense black and 140 other colors, while the expected numbers obtained were 107 intense black agouti and 140 other colors, while the expected numbers are 105.3 intense black agouti and 141.7 other colors, respectively.

Another cross with mice recorded by Phillips and the writer[2] (1913) will serve to illustrate the case of four factors. Here the ratio expected is one animal having the character in question, to 2.16 lacking it.

From Table I.[3] it will be seen that there are in F_2 436 animals possessing the character in question (intense black agouti) to 744 lacking it, the expected numbers being 373 to 807.

As the number of factors increases, the ratio of animals which *do not* show the character to those that do increases rapidly.

With 10 factors it becomes 16.7:1, with 15 factors, 73.8:1, and with 20 factors 314.3:1.

It will be convenient to present this in tabular form as follows:

Number of Factors	Ratio of Animals Lacking Character to Those Having It
1	1:3
2	1:1.3
3	1.3:1
4	2.1:1
5	3.2:1
10	16.7:1
15	73.8:1
20	314.3:1

The general principle involved is that, with the addition of each factor involved, the number of F_2 animals possessing the character in question is multiplied by three, while the *total* number of F_2 zygotes is multiplied by four. It will be seen, therefore that the difference between the number of animals *with* the char-

[2] Little, C. C. (1913) and Phillips, J. C., "A Cross Involving Four Pairs of Mendelizing Characters in Mice," *Am. Nat.*, Vol. 47, pp. 760–762.

[3] *Loc. cit.*, p. 761.

acter and those *lacking* it grows progressively greater with each factor added.

The practical value of the principle may prove to be considerable as it serves to explain cases in which a character dominant in F_1 almost completely disappears in F_2, and in which an apparently non-mendelian result is obtained involving a reversal of dominance.

For supposing that a certain character, x, depended for its visible manifestation upon the simultaneous presence in the zygote of 20 factors which we may designate as A, B, C . . . T. Then if an animal possessing this character and the above mentioned factors is crossed with one from a race lacking all these factors, F_1 *would all be of the formula Aa Bb Cc . . . Tt. All would develop the character in question since all had a single representation of the twenty factors. If, however, these* F_1 *animals were bred inter se* F_2 *would give approximately only one animal in 314 which had the character in question.* If only a small number of F_2 were raised the character might well be thought lost and perhaps not truly inherited by F_1.

An entirely different result would, of course, be obtained if the factors in question needed to be present in *all* the gametes of the zygote in order for the character to be visibly manifested. In such a case as this none of F_1 would show the character, and its reappearance in F_2 would follow the ordinary rules of mendelian segregation and recombination.

This note is merely offered in the hope that it may be of use in the explanation, on a Mendelian basis, of certain results which might otherwise be offered as examples of non-mendelian inheritance. C. C. Little

Bussey Institution,
Harvard University

THE STRUCTURE OF THE COTTON FIBER

In any kind of cotton the typical fiber, that is the one in which all the essential parts may be determined, can be found in rare cases. For this reason the structure of an ideal fiber can be inferred only from a series of studies of fibers in successive stages of development.

By subjecting such fibers to certain chemical and bacteriological treatments and then studying them under the microscope, we found that the typical cotton fiber consists of the following parts:

1. The outer layer or the integument.
2. The outer cellulose layer.
3. The layer of secondary deposits.
4. The walls of the lumen.
5. The substance in the lumen.

1. *The outer layer or the integument* is the incrusting layer and forms the cementing material of the fiber. Its chemical structure is not an homologous one, but is a mixture of components, some soluble in alcohol, some in ether, and some in water. The components are cutinous, pectinous, gummy, fatty and other unidentified bodies.

2. The *outer cellulose layer* is in its structure a distinct spiral, consisting of a limited number of component fibers, perhaps of one or of two. The structure of this layer is determined under the microscope from a longitudinal section of the fiber after the latter has been subjected to a series of chemical and bacteriological treatments. Careful treatment of some of the fibers by cuprammonia will show under the microscope this spiral. There is some evidence to show that this spiral consists of impure cellulose.

3. The *layer of secondary deposits* seems to be made up of component fibers which in no case have shown a spiral structure. Unlike the fibers of the above described layer, these components are from about five to ten in number and run with some irregularities along the length of the fiber.

4. The structure of the layer forming the *walls of the lumen* is a spiral much the same as the outer spiral, but differs from it greatly in its chemical composition. This is determined from a microscopical study of the fiber while under a cuprammonia treatment.

5. *The substance in the lumen* is structureless and, as is proven by a microscopical test, is of a nitrogenous nature.

B. S. Levine

The Biological Laboratory,
Brown University